ENGINEERING CONSTRUCTION WEEKLY

SEP 30 1939

ENGINEERING NEWS-RECORD

SEPTEMBER 28, 1939

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THIS WEEK

● Municipal engineering subjects are given a large part of the stage in this issue in order to help focus attention on the problems of public works officials, problems that will be discussed at the Public Works Congress of the American Public Works Association in Pittsburgh next week. Included is a notable article on modern methods of sewer design and construction and a description of how the engineers of Miami handle public works to keep pace with a fast-growing community. Also given is a quick summary of the important papers at the Montreal meeting of waterworks men.

● The high spot of the issue for all engineers concerned with water supply is the waterworks inventory given in tabular form. This is a complete and up-to-date summary of the nation's water supply systems.

● For men outside the municipal field the issue contains an article on the fast-grading operations for the Pennsylvania Turnpike, the nation's first long distance toll road, and a description of problems involved in relocating the Southern Pacific rail line around the Shasta reservoir.

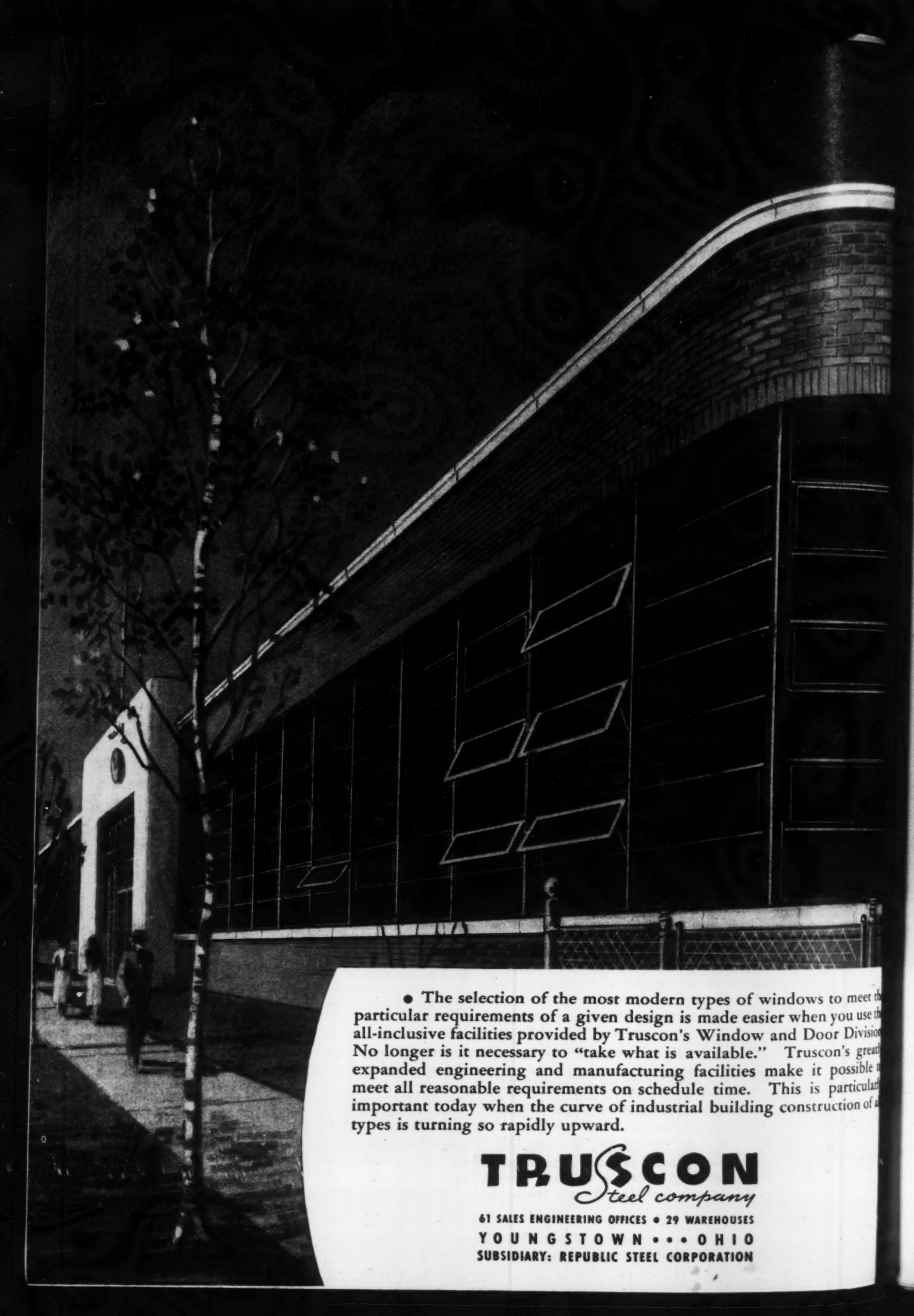
● Bridge engineers will find the description of the new pontoon bridge at Istanbul worthy of special note.

● For contractors, the rock-crushing plant at Hiwassee Dam with its elaborate system of dust-control records an important advance in handling rock high in silica.

THINGS TO COME

ROSS DAM, being built in remote mountain region in the state of Washington, put before the contractors one of the most difficult transportation and plant layout problems of recent times. Its unique features are to be described in the Oct. 12 issue.

THE October 26 issue will be a Special Building Number.



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Volume 123 SEPTEMBER 28, 1939 Number 13

Federal Housing Loans Near Half Billion Mark

Loan contracts to local housing authorities for construction of low-rent projects to re-house low-income families neared the $500,000,000 mark last week when President Roosevelt approved additional loans totaling $25,000,000.

The USHA so far has $494,000,000 in loan contracts with which local housing authorities in 130 communities are building homes for the low-income group. Besides this, there are outstanding earmarkings of $178,000,000, making a total of $672,000,000 in USHA commitments for 161 communities.

• • •

Public Utility to Spend $1,500,000 on Expansion

The directors of the Safe Harbor Water Power Corp. Sept. 22 authorized expenditures of about $1,500,000 to increase facilities of its hydro-electric plant at Safe Harbor, Pa., the plant's present capacity of 53,000 kw. to be increased to 78,000 kw.

The added capacity is required to provide additional power for the Pennsylvania R. R., which anticipates traffic increases over its electrically-operated lines. Work is scheduled to start in January. No public financing is planned.

• • •

Epidemic Causes Strikes On Illinois Hospital Work

With the death list of the typhoid fever outbreak at the Illinois State Hospital for the Insane near Manteno, Ill. (*ENR*, Sept. 7, p. 306) totaling 35 on Sept. 20, workmen engaged in constructing new buildings for the institution have struck on two different occasions demanding assurance that the contractors will pay the medical bills for any men who may contract the disease.

WPA Head Cannot Thwart Congress

Attorney-General emphasizes limit of exemptions to 130-hr. rule of 1939 Relief Act

The authority given to WPA Commissioner Harrington in the 1939 relief act to grant exemptions in certain cases from the rule that WPA men must work the 130 hr. per month must not be used to thwart the intent of Congress, Attorney-General Murphy stated emphatically in an opinion delivered last week. A strike in protest against the new rule is not sufficient grounds for such an exemption, he said.

The law permits the commissioner to return to the prevailing wage principle in cases where it is necessary in order "to protect work already done on a project." Last July the Conference of Mayors submitted a brief to Harrington contending that, because of the strike of skilled WPA workers then underway and still theoretically in force, he ought to exempt all projects started before July 1, 1939. The brief was turned over to Murphy for an opinion.

Pointing out that "an exception in a statute must be construed . . . in a manner not inconsistent with the pur-

(Continued on p. 32)

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South Carolina Citizens To Vote on Bridge Purchase

Voters of Charleston County, S. C., will vote Oct. 17 on whether or not the county should purchase the $6,000,000 Cooper River toll bridge between Charleston and Mount Pleasant, a cantilever span on U. S. Highway 17. No purchase price has been agreed upon but it is understood that the board of commissioners will not purchase the structure unless the price is such that anticipated toll revenues will be sufficient to repay the state without additional taxes.

Concrete Pouring Record Set At Grand Coulee Dam

Three new records were established at Grand Coulee Dam last month as the contractors, relieved of the cement shortage delaying the work earlier, speeded up operations. MWAK's monthly record concrete placement of 395,945 cu.yd. was broken for the first time when Consolidated Builders, Inc., finished August with a placement figure of 397,994 cu.yd. The former 10-day record of 155,695 established by MWAK was broken when 159,042 cu.yd. were placed between Aug. 21 and Aug. 31. Finally, on Aug. 27, Consolidated unloaded 81 cars of cement; the previous record was 79 cars.

Cement pouring at Grand Coulee went onto a seven-day week Aug. 27 and will be continued on this schedule until cold weather shuts down the work.

• • •

Lincoln Electric Pledges No Rise in Prices

A pledge to maintain its present prices as far as possible and to prevent any inflationary moves for unjustified price increases was made Sept. 14 by the Lincoln Electric Co., Cleveland, through its president, James F. Lincoln. Lincoln, an industrialist, stated that much of this post-war trouble would be eliminated by a more foresighted price policy on the part of manufacturers and distributors. Price inflation by the seller when he has a dominant position results inevitably in reaction with deflation, depression and suffering, he asserted.

• • •

Illinois Work Held Up Due to Wage Rates

Lettings on state highway work in Illinois were held up for a month and half due to the necessity of highway officials furnishing prevailing wage schedules in accordance with a law passed by the last state legislature, there having been no letting dates between Aug. 4 and Sept. 26.

Army Engineers Approve Chattanooga Project

U. S. Army Engineers have recommended to Congress construction of a $20,056,000 flood protection project at Chattanooga, Tenn., and nearby Rossville, Ga. Construction of the main works around the city proper is urged immediately at an estimated cost of $16,642,000, while construction of the remainder of the project, designed to protect outlying sections, would be deferred to some future date.

The general plan calls for construction of levees and flood walls with necessary sewer and drainage structures, pumping plants, creek diversions, and railroad and street modifications. In anticipation of this favorable report by the Army Engineers, The Senate Commerce Committee earlier this year inserted in the House-approved omnibus rivers and harbors bill an amendment authorizing construction of the Chattanooga project. However, the bill faces a stiff battle from the economy bloc when it comes up in the Senate, and a fight is expected on this project.

On January 9 of this year, the Tennessee Valley Authority recommended the construction of $15,500,000 of flood protective works at Chattanooga. This report, similar to that of the Corps of Engineers, is pending before the House Military Affairs Committee, to which all TVA reports are automatically referred.

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WPA Head Restricted In Wage-Rate Change

(Continued from p. 31)

pose and intent of the statute," Murphy said that it was the clear intent of Congress to eliminate the payment of prevailing-wage rates. The mere fact that a strike is in progress and that cities are inconvenienced, Murphy said, is not grounds for an exemption.

If an unavoidable condition arose, however, which was "not due merely to an effort or desire to nullify the expressed will of Congress," by which the investment in a project was emperilled, then exemptions might be granted. Such exemptions might take the form of exempting all projects which had reached a certain degree of completion at the effective date of the act. Murphy added that the commissioner "might well consider whether the aditional cost . . . due to the exemption would exceed the public investment already made."

Commissioner Harrington has refused to make any comment on the decision or to indicate whether any action will be taken.

Thaddeus Merriman Dies: Authority on Hydraulics

Thaddeus Merriman, consulting engineer to the Board of Water Supply of New York City and former chief engineer of that body, died in New York on Sept. 26. He had been confined to his home most of the time since he returned from a trip to the Pacific Coast in July.

Thaddeus Merriman was born in New Haven, Conn. in 1876, graduated from Lehigh University in 1897, and soon thereafter joined the staff of the Nicaragua Canal Commission, serving as a rodman and transitman for a year, and then as a designer in the Washington office. From July 1899 to July 1900 he was chief of party on location surveys in Nicaragua for the Isthmian Canal Commission.

Returning to New York in the fall of 1900, Merriman was first engaged by the New York Continental Jewell Filtration Co. on design of filters for Little Falls, N. J., and then was with the East Jersey, Passaic and Acquackanonk water companies on Boonton Dam and general hydraulic work.

In 1905 Merriman joined the staff of the New York Board of Water Supply and continued actively in the service of that board until his retirement from the position of chief engineer in 1933. Work on the Catskill system was just getting underway when Merriman started work with the board, first as an assistant engineer on general plans and estimates and then in the reservoir department on studies for Ashokan Dam. In 1907 he was made assistant to the chief engineer, J. Waldo Smith, and in 1914 was made department engineer in charge of the headquarters department. In 1918 he was appointed deputy chief engineer, and four years later when J. Waldo Smith retired he was appointed chief engineer. Thus he had an active part in the entire job of building the Catskill water supply system.

Merriman also had active part in the preliminary work of the Delaware system, now under construction. From 1923 to 1927 he represented the Board of Water Supply in the negotiations with Pennsylvania and New Jersey over allocation of the waters of the Delaware River. Since his retirement, Merriman has acted as consultant to the board on problems of the Delaware system.

In recent years Merriman has served on numerous consulting boards including the engineering board of review of the Metropolitan Water District of Southern California and on two Fort Peck Dam Boards.

For many years Merriman has made a special study of Portland cement and contributed extensively to research studies of both the American Society of Civil Engineers and the American Society for Testing Materials. He served as editor-in-chief for the American Engineers Handbook and was author of other engineering texts.

• • •

Power Commission Seeks Connecticut River Control

The Federal Power Commission on Sept. 22, initiated proceedings to determine whether a license is required for the operation of a hydro-electric project on the Connecticut River at Bellows Falls, Vt. The Bellows Falls Hydro-Electric Corp. and the Connecticut River Power Co., named as respondents, were ordered to file their responses by Oct. 18, a hearing on the issue involved being set for Oct. 23 at Washington, D. C.

One of the important questions to be decided is whether or not the Connecticut River is a navigable water. On this question the commission's order contains voluminous citations of the results of the investigations thus far conducted, pointing out that the corporation now owning and operating the hydro-electric project at Bellows Falls was originally incorporated under the name of "The Company for Rendering Connecticut River Navigable by Bellows Falls," and that for half a century this company collected tolls from the boats, rafts and other river traffic.

The Connecticut River Power Co. is named a respondent because of its ownership and operation of certain transmission lines appurtenant to the hydro-electric project at Bellows Falls. All the companies named are in the New England Power Association system.

The Commission has agreed to the withdrawal by the New England Power Co. of an application filed July 20 and amended July 22 seeking authorization to acquire the electric facilities of the Bellows Falls Hydro-Electric Corp. and certain appurtenant transmission lines of the Connecticut River Power Company.

Illinois Engineers Hold Annual Conference

The Illinois State Assembly of the American Association of Engineers held its fourth annual conference in Peoria, Ill., on Sept. 23, with 200 engineers representing all branch of the profession present. Social and economic problems of the profession were discussed, particularly public relations and civic responsibilities, including registration of engineers, classification and compensation, and civil service.

The assembly endorsed without reservation the new "Standards on the Classification and Compensation of Professional Engineering Positions" prepared by the parent association. Committees were appointed to compare the standards with actual salaries now paid in industry and governmental agencies in Illinois and to conduct a vigorous campaign to raise substandard salaries to the levels recommended by American Association of Engineers.

The discussion in the conference indicated that Illinois salaries have fallen far below the level recommended due to the surplus of engineering services available during the depression. It was pointed out that although that surplus is being absorbed, salaries are remaining almost at the level of those paid when industrial demand for engineering services was at lowest ebb. Discussion from the floor indicated also that work-relief projects of the federal government and state during the depression, which gave a majority of engineers employment during that period, have set up salary levels in some instances lower than those paid unskilled labor and that those work-relief standards of pay threaten to become general for corresponding work in private enterprise.

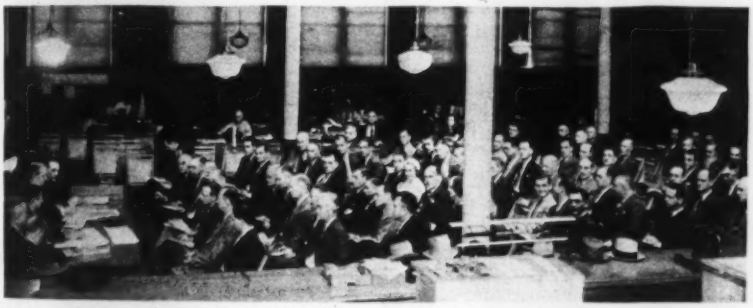
Among resolutions adopted was one calling for the passage of a registration law in Illinois covering all engineers. The Illinois law now covers only structural engineers.

Everett C. Shuman, Professor of Civil Engineering, Lewis Institute, Chicago, president of the American Association of Engineers, addressed the meeting on the subject "The Engineer's Responsibility in the Present Crisis." He urged professional engineers to integrate for more capable performance of civic duties during these turbulent times.

• • •

Miami May Purchase Distribution System

Negotiations started five months ago to make possible purchase by the city of Miami, Fla. of its water distribution system are expected to be brought to a head this week, according to L. L. Lee, city manager. Carl F. Lambert, engineer employed by the city; Malcolm Pirnie, the engineer employed by the Florida Power & Light Co. which owns the distribution system, and L. R. Howson, Chicago, are expected to reach a fair purchase price at that time.



CONTINENTAL DIVIDE TUNNEL BIDDERS SCARCE IN THIS CROWD

THIS CROWD gathered in the Denver offices of the U. S. Bureau of Reclamation on Sept. 21 for the opening of bids on the 13.1-mile Continental Divide tunnel on the Colorado-Big Thompson project, but bids were scarce. Keystone Construction Co., San Francisco, a group of large Western firms, submitted the only complete bid that met specification requirements, $10,350,105. Two other bids were submitted, both considered by bureau officials as informal. Warner Const. Co., Chicago, contractor on the Green Mountain Dam of the same project, tendered a proposal accompanied by a nine-page letter of stipulations, estimating the cost at $8,612,733. Solomon & Hinkle, Fairfax, Okla., offered to drive the tunnel at cost plus a fee of 4 per cent. The Keystone bid is only $409,000 lower than that submitted by the Shasta Const. Co., San Francisco, at the first opening held last June 7. The former bid, one of two received, was rejected as being too high. The tunnel, 9½ ft. in diameter, must be driven from two portals only, to avoid despoiling the Rocky Mountain National Park with shafts or adits.

Wage Uncertainties Delay Federal Work

Requirements of the Bacon-Davis law result in postponement of important bid openings

Disturbed by the postponement of a bid-opening on Friant Dam early this month and the postponement last week of award of contract for a section of the Contra Costa Canal, both caused by wage-rate changes, lawyers of the Department of the Interior are now engaged in a study of the Bacon-Davis Act —the law which requires payment by federal public works contractors of wage rates certified by the Department of Labor to be "prevailing rates".

Present procedure under the Bacon-Davis Act is for the contracting agency, in this case the Bureau of Reclamation, to request a wage determination from the Labor Department at the time the specifications are drawn up. The department prepares such a determination, usually on the basis of local hearings, and this is incorporated in the specifications. However, any interested person is free to protest at any time against the determination and present evidence either that the determination was wrong or that the situation has changed. When such a claim is presented, ordinarily by a union, the department investigates and if it finds the objection well-founded makes a change in its wage determination—which must then be incorporated in the specifications by means of a published addendum.

Late changes

If the change is made too late to permit notifying bidders before the bid-opening, the opening must be postponed—as happened in the Friant Dam case. An even more serious situation arose in the case of the Contra Costa Canal section. In this case a complaint was registered some time before bids were opened, but the Bureau of Reclamation decided to go ahead anyway. By the time Labor had decided the complaint was justified the bids had been opened; award of the contract has been deferred while it is decided whether new bids must be taken.

These possibilities of delay are regarded as especially unfortunate at the present time when the price situation is so unsettled. It is believed in some quarters that the bids received on Friant Dam Sept. 14 were $500,000 higher than they would have been if the bids had been opened Aug. 24 as originally planned.

The position of the Department of Labor is that the act requires the mini-

(*Continued on page* 35)

San Francisco Bridge Tolls May Be Reduced Again

Reduction in the San Francisco-Oakland Bay Bridge tolls from 40 to 35 cents may be made before Jan. 1, according to Frank W. Clark, California state director of public works and a member of the California Toll Bridge Authority. An increase in the Bay Bridge traffic is expected to make the toll reduction possible. The bridge now is carrying a monthly average of 1,000,000 motor vehicles. A short time ago tolls were reduced from 50 to 40 cents.

• • •

Railroad Sues Contractor After Bridge Accident

The Boston & Maine Railroad Co. has filed suit in the county superior court at Portsmouth, N. H. against the Frederick Snare Corp., New York, seeking to gain $150,000 to repay damages and losses sustained in the displacement of the Portsmouth-Kittery Bridge on Sept. 10, which killed two people (*ENR*, Sept. 14, p. 317). The New York company is the contractor on the substructure of the new highway and railroad bridge being built across the Piscataqua River, it being alleged that a large caisson broke loose and struck the railroad bridge forcing it out of line.

• • •

St. Louis Cannot Collect 1940 Taxes on Park Area

A judge of the federal court in St. Louis Sept. 7 handed down a ruling that the city of St. Louis has no just claim for 1940 taxes it had levied against the real estate in the area acquired by the federal government June 16 for the Jefferson Memorial Park. It can collect the 1939 taxes up to June 16 and for any period of time the property continues in private possession after the 60 days allowed for vacating the property has passed.

The city had sued for both the 1939 and 1940 taxes on the ground that the levying for the latter year had begun June 1. The judge pointed out in his opinion that the tax levy as provided for in the city charter would not be completed until Jan. 1, 1940.

Funds covering the city's claims for both years were deposited in the court's registry as the government acquired each tract.

• • •

Texas Sues Trucking Firm For Damages to Bridge

Suit for $10,798 as damages for the destruction of a bridge over Denton Creek north of Carrollton, Tex., on Nov. 22, 1937, when a truck crashed through the span, has been brought by the state of Texas against the Jackson-Stricland Transportation Co., Inc., Houston, and Reagan Sayers, trustee in bankruptcy for the firm.

THIS WOULD HAVE BEEN WORLD'S LONGEST CONCRETE ARCH

THE COLLAPSE on Aug. 31 of this timber centering over the Angerman River between the villages of Lunde and Sando in Sweden brought disaster to plans for building the world's longest concrete arch bridge and cost the lives of 18 construction workers.

Prof. Inge Lyse, well-known concrete expert, recently of Lehigh University and now at Norway Institute of Technology in Trondheim, Norway, has sent *ENR* the following information on this great pioneer effort of the Swedish engineers.

The theoretical span of the bridge was to be 866 ft. which compares with the 590 ft. Plougastel bridge in France and the 593 ft. Traneberg bridge in Stockholm, longest existing concrete arches. The cross-section of the arch is a three-cell hollow section, 31 ft. wide, 8¾ ft. thick at the crown and 14¾ ft. thick at abutment. The external walls of the hollow section are 11⅞ in. and the internal walls 7⅞ in. thick, well reinforced.

The bottom slab of the section would be poured first, then the walls and last the top slab. The length of the arch was divided into many sections, each section to be allowed to harden before filling the portions between. At the time of the accident only parts of the bottom slab had been completed. The workmen were cleaning the forms and preparing for pouring the final section of the slab at the top of the arch when the timber centering failed.

The centering was built on a framework along one shore of the river, and last spring was floated into place on two barges and lifted onto the abutments. It had a center clearance of 135 ft. for shipping.

A description of the bridge project was given in an article by Rudolf Kolm in the Swedish concrete magazine "*Betong*", Häft 2, 1938. There it is stated that the bridge consists of two portions, the arch span section over the river proper and a girder span section over a branch river; the latter included a 234 ft. concrete girder span. The maximum stresses permitted in the concrete were 1630 lb. per sq. in. for the arch and 1350 lb. per sq. in. for the girders. First-class concrete under most rigid control was required. The bridge deck consists of a 31 ft. roadway with 4 ft. bicycle lanes on each side.

Wages Delay Work

(Continued from p. 33)

mum wages to be those prevailing at the time the contract is let. However, the Corps of Engineers, the Quartermaster Corps and the Public Buildings Administration—the chief contracting agencies in the federal government besides the Bureau of Reclamation—have not had as much trouble as might be expected from such an interpretation. Through a process of informal liaison these agencies have kept the Labor Department apprised of their opening dates, so that the Labor Department is able to discourage complaints coming in so late that even a telegraphic addendum could not reach bidders before the opening date. Similarly, when the department receives a complaint indicating possible delay, the contracting agency is notified at once and can make arrangements in advance. On smaller jobs, too, if a late revision comes in, bidders assembled for the opening are sometimes told that the wage rates have been changed and if no one objects the bids are opened anyway.

Reclamation projects

This informal process appears not to have worked so well with the Bureau of Reclamation. Reclamation projects are generally so large that even small changes in wage rates are of considerable significance. Moreover a considerable period of time frequently elapses between preparation of specifications and opening of bids, giving an opportunity for the wage situation to change. And relations between the Labor Department and Reclamation Bureau have not been as cordial as with some of the other agencies.

Reclamation officials are anxious to pin down this informal arrangement into a definite interpretation of the Bacon-Davis Act. They feel the law will be satisfied if minimum wage rates are established as prevailing at the time of the bid call. Interior Department lawyers are studying this and an attempt will be made to get the Labor Department's legal staff to agree to this interpretation. If this proves unsuccessful, the matter will be carried to the Attorney-General's office. It may prove necessary to seek Congressional action.

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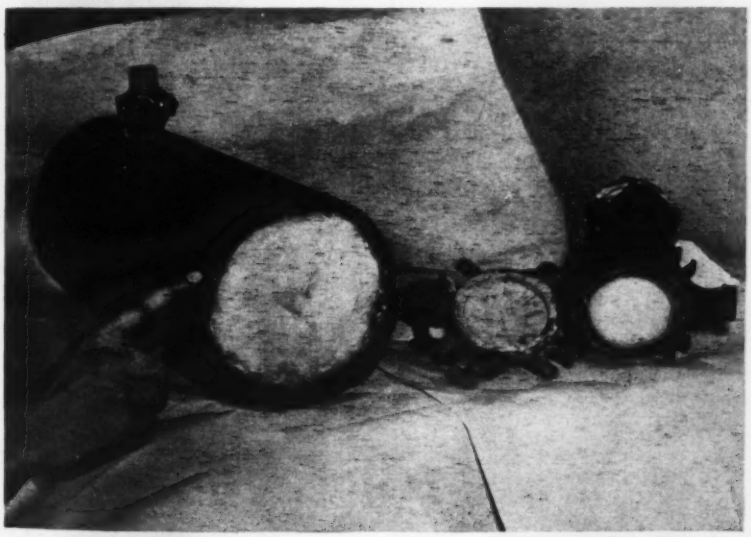
Tully Low Bidder On Chicago Subway

When bids were opened Sept. 21 for Section F-4B of the new Chicago subway under State St., J. C. Tully Co., 33 No. LaSalle St., Chicago, was low bidder with the bid of $803,000.



Plain Dealer Photo

PARAFFIN CLOGS CLEVELAND WATER MAIN

RECENTLY WHEN a group of householders at Cleveland complained that they could get no water from the city's main, workmen sent to investigate found that the water main clogged with paraffin, also the fire hydrants. The pipes clogged included a 600 ft. length of an 8-in. cast iron main and a great length of 6 in. pipe.

Further investigation revealed that someone at the nearby Standard Oil Co. plant had made a mistake and turned liquid paraffin into the water main instead of the refining line. Frank O. Wallene, utility director at Cleveland, reports that normal pressure within the main was 40 lb. per sq. in.

The oil company has agreed to pay for the damage, one estimate of total damages being $3,000.

Massachusetts Requires Naming Subcontractors

General contractors bidding on state work costing over $5,000 must list expected subcontractors

A new Massachusetts law (Chap. 480) requires that all general contractors bidding on public building work over $5,000 for the state or over $1,000 for other political agencies must submit with their bids a complete list of subcontractors and material supply dealers, and the amount of the sub-bids, which are to be used in performance of the contract. Furthermore, each subcontractor and material man submitting bids to a general contractor must, two days prior to opening of general bids, file a copy of his bid with the awarding authority, including a list of general contractors to which the proposals have been made. The successful general contractor cannot use any sub-contractor who has not filed a copy of his bid with the awarding authority.

To examine sub-bids

After selection of the general contractor, the awarding authorities are to examine all of the sub-bids filed and if they so desire, may call a joint meeting of the general contractor and, architect or consulting engineer to consider any subcontractor proposal lower than that named by the general contractor. If a lower price is available, it is up to the contractor to either accept it or substantiate an objection to "the standing and ability" of the subcontractor making the low proposal. If the lower sub-bid is accepted by all concerned, an adjustment in the amount of the contract will be made. In case the contractor's named subcontractor fails to sign an agreement within ten days, a selection is made from other proposals submitted, and if the price is higher, a corresponding adjustment is made on the amount of contract.

The specifications are to list the trades and materials for which subcontractors are expected to submit proposals. If the general contractor intends to do any of the listed work himself, he must submit a subcontractor's bid in his own name, which will be considered the same as any other such bid. Furthermore, he must show that it is his usual practice to do such work. Apparently, once receiving bids from subcontractors for certain work, the general contractor will not be allowed to perform such work himself.

Both general and subcontractor proposals are to be made on special forms as designated by the law. Several general contractors have expressed doubt as to the law's workability.

OBITUARY

THOMAS J. SKILLMAN, 62, chief engineer of the Pennsylvania R. R. for 8 years, died Sept. 24 in Ardmore, Pa. Skillman was graduated in 1898 from Princeton University with a degree in civil engineering. He soon joined the Pennsylvania R. R. as a blueprint boy, next became rodman, was later advanced to division engineer at Cape Charles, Va. and in 1914 was transferred to Camden, N. J. in the same capacity. In 1917 he was appointed division engineer of the Monongahela Division at Pittsburgh and soon afterward was made chief engineer of the Long Island R. R. Promotion to the post of chief engineer of the entire Pennsylvania system came in 1927. He had to give up that position eight years later because of ill health. Skillman entered Pennsylvania service again in 1936 as chief engineering consultant.

THOMAS M. DORSEY, 78, retired building contractor, died recently at Louisville, Ky.

W. C. PLACHY, 83, retired civil engineer of Seattle, Wash., died there Sept. 21. He was a graduate of Northwestern University and had been with the Seattle engineering and water departments for more than 40 years, serving as city engineer in 1889.

HENRY M. RICE, Atlanta, Ga. contractor, died last week at Hapeville, Ga. For the past 34 years he had been in the contracting business, dividing his time between Miami, Fla. and Atlanta.

CHARLES W. JOHNS, chief engineer of the Chesapeake & Ohio Ry., died Sept. 15 at Clifton Forge, Va. at the age of 63. He joined the Chesapeake & Ohio in 1899 as an instrument man and was promoted rapidly, becoming chief engineer in 1923. At one time he was engineer of maintenance of way at Huntington, W. Va., leaving that position to become engineer of branch lines with headquarters at Richmond, Va.

THOMAS D. PIERCE, Indianapolis, Ind. consulting engineer, died Sept. 16 at the age of 60. Following one year of engineering work at the Western Reserve University, he attended Case School of Applied Science for two years, studying civil engineering. After a short period with the Duplex Catch Basin Co., Cleveland, O., he joined the F. A. Pease Engineering Co., Cleveland, as transitman. In 1903 he joined the Erie R. R. but soon became connected with the Indiana Public Service Commission. In 1931 he opened his own office under the title of Pierce & Associates, specializing in the field of municipally owned utilities.

ANDREW M. O'BRIEN, 83, retired building contractor of Lockport, N. Y., died Sept. 17.

ANDREW H. HOGAN, at one time member of the Hogan & Wold, contracting firm of Fargo, Minn., died recently at Fargo.

CHARLES P. RIECHERS, SR., for more than 50 years a building contractor at St. Louis, died Sept. 14 at the age of 72.

JOSEPH A. ROCHWITE, 66, retired contractor, died Sept. 14 at St. Louis, Mo.

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California Water Company Sold to N. Y. Utility

Purchase of all the outstanding common stock of the California Water Service Co., which serves widely scattered California communities, by the General Water Gas & Electric Co. of New York, has been approved by the Securities and Exchange Commission.

The California company serves 31 communities and according to the commission's announcement is to receive $3,276,000 as payment for the stock. This includes $48,000 in accrued interest and $26,000 estimated expenses. The California Co. was owned by the Federal Water Service Corp.

Data Gathered as MWAK Seeks Additional Pay

Representatives of the federal government are busy at Grand Coulee Dam gathering data to offset the claims of the Mason-Walsh-Atkinson-Kier Co. for $5,000,000 additional pay for building the low dam at Grand Coulee. An attorney for the U. S. Department of Justice is now on the project to work in conjunction with Frederick Hamley, resident attorney for the Bureau of Reclamation, and the government is getting ready to offset the claims of the contractors.

The MWAK company after completion of its $29,000,000 contract filed a number of claims against the government, charging that the Bureau's inspectors were too stringent in their interpretation of the contract phases and that the company was called upon to do more work than it was paid for. When the company submitted its claim to Secretary of the Interior Ickes he did not see the necessity for a hearing to decide the justification for the company's charges. On May 1, 1939, the company began action in the U. S. Circuit Court of Claims, listing 31 different causes of action and claiming more than $5,000,000 additional payment.

Acme Photo

MISSISSIPPI RIVER BRIDGE AT LA CROSSE, WIS., DEDICATED

THE NEW $1,500,000 Mississippi River bridge at La Crosse, Wis., was dedicated Sept. 23 and has been opened to traffic. The structure, which is 2,626 ft. long including approaches, supplies a 30-ft. roadway and carries U. S. highways 14, 16 and 61 across the river. It is toll free. The Minneapolis Bridge Co., Minneapolis, was contractor for the substructure; and the Klug & Smith Co., Milwaukee, Wis., built the superstructure. Engineers of the Wisconsin state highway commission did the design work, the State of Wisconsin being the owner. E. L. Roettiger is state highway engineer and C. H. Kirch, bridge engineer.

Susquehanna River Reaches Record Low Stage

The north branch of the Susquehanna River Sept. 21 reached its lowest level in the history of government recordings, according to the Federal-State Forecasting Bureau at Harrisburg, Pa. The stage at Wilkes-Barre, Pa. was 0.072 ft., the stage at Towanda, Pa. reached a record low of —0.18 ft., and at Harrisburg the stage was 2.79 ft. or within 0.02 of the lowest level. At Wilkes-Barre readings have been taken since March 1899, readings at Towanda since 1892.

Ohio Highway Staff To Be Increased

Additional engineers are to be hired to assist in preparing plans for a $12,000,000 construction program which is to be started on Jan. 1 by the Ohio state highway commission, according to State Highway Director Robert S. Beightler. The program is being financed with $7,500,000 in federal funds and $4,500,000 of state money. Improvements will be confined to principal highways and federal secondary roads. $3,000,000 is to be used for constructing bridges.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $43,511,000, are 12 per cent below the corresponding week last year, and 31 per cent below the revised volume of a week ago.

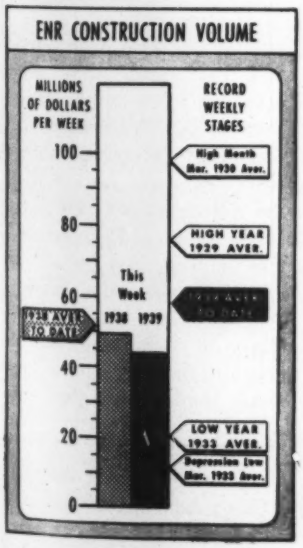
The current week's total brings the 39-week 1939 volume to $2,265,252,000, a 13 per cent increase over the $1,999,760,000 for the corresponding period last year.

Private awards for the week are 64 per cent higher than in the 1938 week, but are 29 per cent below a week ago. Public construction is 29 and 33 per cent lower, respectively than last year and last week.

In the classified construction groups, industrial buildings and unclassified construction top their respective volumes for the 1938 week, and waterworks, sewerage, and unclassified construction are above their totals of a week ago.

New capital for construction purposes for the week totals $8,856,000, an 83 per cent decrease from the volume for the 1938 week. The current week's new financing is made up of $5,695,000 in corporate security issues, and $3,161,000 in state and municipal bonds.

New construction financing for the year to date, $2,178,952,000, is 30 per cent lower than the $3,112,868,000 reported for the 39-week period last year.



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CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 29 1938	Sept. 21 1939	Sept. 28 1939
Federal	$4,297	$10,898	$2,694
State & Municipal	35,811	31,533	25,880
Total public...	$40,108	$42,431	$28,574
Total private..	9,121	20,917†	14,937
TOTALS	$49,229	$63,348†	$43,511
Cumulative			
1939 .....(39 weeks)....			$2,265,252
1938 .....(39 weeks)....			$1,999,760

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

† Revised.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 39 Wk.	1939 39 Wk.
NON-FEDERAL	$1,973,750	$1,050,924
Corp. securities...	332,077	181,404
State & Mun.....	441,094	412,797
R.E.A. loans.....	46,595	89,445
R.F.C. loans.....	97,391	4,315
P.W.A. allot.....	652,286	.....
U.S.H.A. loans....	202,807	172,963
Fed. Aid—Hwys...	201,500	190,000
FEDERAL	$1,139,118	$1,128,028
TOTAL CAPITAL...	$3,112,868	$2,178,952

FHA MORTGAGES

	Week Ending Sept. 24 1938	Sept. 16 1939	Sept. 23 1939
Selected for appraisal ...	$23,569	$22,514	$22,650*
Cumulative			
1939 .....(38 weeks)...			$851,248*
1938 .....(39 weeks)...			$737,287

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Sept.....	234.97	112.95
Building Cost	Sept.....	196.61	106.28
Volume	Aug.....	228	100

Canadian Works Not Suffering

Declaration of war does not prevent many provinces from continuing projects

Initial effects of the declaration of war by Canada have not been serious. For the most part, contracts for the several million dollars worth of federal work will not be rescinded but work will proceed as usual. The province of Prince Edward Island will continue with projects and contracts of the present fiscal year without major changes and in Nova Scotia normal construction is expected.

The Public Works Department of New Brunswick is going forward with current operations and no curtailment in present contracts is expected. Quebec's present road program will be finished without cancellation of any contracts.

In Ontario, Toronto's major private construction project, the new bank of Montreal, a 15-story building to cost over $3,000,000, has been shut down by order of the bank authorities; to be completed "as soon as conditions return to normal." Excavation for the work has been completed and the steel erection is well advanced. Ontario's $2,000,000 flood control scheme on the Grand River will proceed as planned; the excavation for the Shand Dam, major item of construction, is practically complete and concreting is in full swing. The Ontario government has also announced that highway construction in the province is being closed down as rapidly as possible because of the increasing costs of materials and the necessity for curtailing public expenditures. The Central Technical School of Toronto, one of the better equipped schools in the Dominion, has been taken over by the Department of National Defense.

In the provinces of Manitoba and Alberta, plans are to advance certain highway and public works programs without important changes. In the province of Saskatchewan officials look forward to completion of its present road program subject to changes rendered necessary by the Dominion's policies.

British Columbia officials have made no statement as to what might be expected in that province during the war. However, business in the shipbuilding industry is likely to be revived as a result of the war, according to R. W. Mayhew, chairman of the British Columbia branch of the Canadian Manufacturers Association.

(News continued on page 84)

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Sag in Cable Spans

Sir: Referring to the approximate formulas given by Paul E. Magerstadt in the July 20 issue, p. 66, and the more refined approximation given by J. B. Macphail in the Aug. 17 issue, p. 202, for computing the lengths of parabolic arcs, I notice they both refer to a rise or sag of 400 ft. for a half-span of 2,000 ft. as extreme cases of deflection in a suspended cable.

Since the sag or deflection at the middle of the span is the same for the full span as for the half-span, a deflection of 400 ft. for a half-span of 2,000 ft. would be the same as the deflection for the full 4,000-ft. span and would therefore refer to a normal rather than an extreme condition.

Maybe I have the wrong interpretation of their statement but that is all I can make out of it.

A. TIGGELBECK
Consulting Engineer
Sandpoint, Idaho

Thickened-Edge Pavements

Sir: If the title of Professor Downs' article "Thickened-Edge Pavements a Failure" (*ENR*, Aug. 3, p. 154) is demonstrated in his text the writer would request further explanation.

As he understands the argument there is postulated a single-lane slab, 10 or 12 ft. wide, 20 to 30 ft. long, with thickened edges on the outer side, while on the inner side it has effective shear devices for transmitting as much as 50 per cent of the wheel load to the adjoining slab. It is then assumed that this slab cracks transversely. Then, if this cracking causes a complete loss of shear transfer, the slab thickness at the crack being seven-tenths of the outer edge thickness, these edges are then only half as strong as the outer edge. Therefore "while such cracks, in the case of the balanced design greatly reduce its safe load carrying capacity, they are not serious if the concrete slab is designed for a uniform thickness;" which is but another way of saying if the slab is everywhere given substantially the same thickness as the outer edge. Hence, presumably, the article's title, "Thickened-edge Pavements a Failure."

The whole case appears to rest on what happens when the crack develops. Is there a serious loss of shear transfer or is there not? Here in Seattle and the state of Washington, where concrete pavements have been used extensively since 1915 and with 3-in. maximum sized aggregate in 6 and 7-in. slabs, with thickened edges since 1923, and joint spacing reduced from 30 ft. to 20 ft. to 15 ft. over the intervening years, cracking has perhaps been quite as extensive as elsewhere, although with 15-ft. spacing of dummy joints it is largely eliminated. But where is the complete loss of shear transfer at cracks by which Professor Downs proves the failure of thickened-edge pavements? Certainly in Seattle and the state of Washington the loss is of small magnitude and there is no valid basis for asserting that thickened-edge pavements are a failure. They do not crumble and break down at the edges of the cracks. On the contrary the interlock of the aggregate at such cracks is such that there is no impairment of service.

The most serious structural weakness in the early pavements which were of uniform thickness was the numerous corner breaks. With the thickening of the edges these have been almost completely eliminated.

The principal purpose and function of the thickened edge is to strengthen the corner, not the edges at interior cracks. The writer is strongly of the opinion that the thickened edges are vastly more serviceable and valuable than many theoretical designs and analyses, which Professor Downs observes require the fulfilment of numerous assumptions to make them work.

The success of the thickened-edge section, however, is based on no assumptions; it is demonstrable in the pavements themselves. Pavement conditions surveys in Seattle have shown that the thickened-edge pavements have developed only a small per cent of as many cracks, corner breaks and serious defects as were found in uniform-thickness pavements of equal age and subjected to equal traffic. And the writer is convinced that in this city and state, in those cases in which the average service life of concrete pavement has not been 20 years, the cause has been inadequate foundation, inadequate drainage, faulty grades and faulty alignment but not the thickening of the edges of the pavements. Also a large mileage of our pavements are not yet 20 years old.

H. F. FAULKNER
City Light Dept.
Seattle, Wash.

Bridges over Waterways

Sir: Your editorial entitled "A Wrong Righted," published in the issue of Aug. 31, congratulates Congress "on having rectified the old error" of requiring railroad companies to pay the cost of new bridges required by navigation improvements on waterways regardless of economic benefits.

So far so good, but you failed to comment on the pocket veto by President Roosevelt which nullified the good work of Congress. The principle and policy approved by Congress recognizes the engineering economics of the transportation problem and is in harmony with the recommendations of committees of American Railway Engineering Association, American Society of Civil Engineers, American Institute of Consulting Engineers and American Engineering Council. The action of Congress was also in accord with the principle advocated by the transportation committee of six appointed by the President.

EDWIN F. WENDT
Consulting Engineer
Pittsburgh, Pa.

The fact that the President vetoed Senate Bill 1989 some time after he had acted on other bills escaped the attention of our Washington office. A search of the record shows that the President went farther than to give the bill a "pocket veto;" he sent a "Memorandum of Disapproval" to Congress on Aug. 11 in which he pointed out that since the passage of the General Bridge Act in 1906 the Secretary of War has had the power to require the alteration of any bridge which may at any time unreasonably obstruct navigation, the cost to be borne entirely by the owner. After citing the fact that the Supreme Court has upheld this act

he went on to say "to require the federal government to pay the cost of alterations which do not directly benefit the bridge owners would impose upon it heavy financial liabilities." Apparently Congress has yet to convince the President of the justice of the cost allocation it proposed to make.—EDITORS.

Vertical Curves

Sir: The writer has calculated and used vertical curves for both railroad and highway purposes for somewhere near 40 years, but never imagined there was any difficulty about them until reading some of the letters on the subject, in *Engineering News-Record*.

In Wellington's "Railway Location" there appears a closed method of calculation, based upon the property that the slope of the parabolic V.C. varies as the length. By a closed method I mean a method which, by checking at the end on a predetermined result, ensures accuracy in intermediate steps.

Wellington deals, if I remember rightly, only with equidistant stations 100 ft. apart, but by the exercise of a minimum of ingenuity, I have developed closed methods for equidistant stations at any intervals, and for unequal station-intervals. I refrain, out of regard for the ingenuity of your readers, from describing these methods in detail.

The ardent souls who use calculus for solving many problems which yield readily to simple arithmetic, remind me of the engineer in Oliver Onion's weird story "Rouum" who "used logarithms for taking out his quantities."

H. ELLIOTT BROWN
Brisbane, Australia

Famous Engineers

Sir: In Farley Gannett's admirable article, "Why So Few Famous Engineers Today?" (*ENR*, Aug. 17, p. 266), the question is asked, "Why were the men named above widely known?"

Is it not true that fame and publicity have, in the last analysis, a synonymous relationship which is applicable not only in engineering, but in all professions where fame seems not to rest on pioneering alone?

Mr. Gannett mentions, among other well-known and famous engineers, the names of Roebling and Goethals, linking the association of these names with two widely known and widely publicized works, the Brooklyn Bridge and the Panama Canal. I wonder whether either of these undertakings could be considered pioneering in engineering, since Roebling had designed and constructed a suspension bridge across the Ohio River at Wheeling for the National Highway many years before the Brooklyn Bridge came into being and Goethals had been in charge of locks and dams of a similar type to those in Panama long before he was assigned to the Panama job, which, after all, was pioneered by the French.

Could not the name of Roebling have been equally well associated with either the Wheeling or the Niagara Suspension Bridge, the latter built in 1855, nearly thirty years before the Brooklyn Bridge was finally completed? It would seem that the answer lies, unfortunately, not in the pioneering efforts of such able engineers as Mr. Gannett mentions, nor yet in the magnitude of their work, but in their ability to carry to a successful conclusion an undertaking which, from its nature and location, is very much in the public eye.

ALFRED R. JAMES
U. S. Construction Engineer
Chillicothe, Ohio

Beauty in Design

Sir: Your correspondent David A. Watt deserves enthusiastic congratulation for his excellent letter headed "Beauty in Design" in your issue of Aug. 17, p. 203. He had no need to question whether his "reminiscing" was a "pleasant proceeding" and his observations on one of the currents of life are indeed illuminating. He would, I feel sure, join in giving all due credit to the architectural profession for their indubitable share in bringing the public, and in turn the engineers, to a proper appreciation of the meaning of beauty in design. The architects were doing their bit valiantly all through the unenlightened period to which Mr. Watt refers, and if they tended at times to overemphasize the aim of beauty at the expense of the aim of utility, who can tell that this was not also beneficial in the long run?

I am sorry I cannot help Mr. Watt to identify the source of his quotation, that "every created thing to perfect its destiny must combine the principles of beauty, truth and use" but should like to add another to it. My personal preference, for one of the canons of design, is a quotation which I ran across years ago in a definition of "Design" in the Encyclopedia Brittanica, by British architect, W. R. Lethaby: "The end of design is properly utility, fitness and delight. If a discovery, it should be a discovery of what seems inevitable, an inspiration arising out of the conditions." Note the order of the words "utility, fitness and delight", and compare this with the order of the words "beauty, truth and use" in the other quotation, remembering that it was an architect who wrote the former. I have long maintained, and if I read Mr. Watt's letter correctly he would agree, that the proper attainment of the first two, utility and fitness, will almost inevitably and automatically lead to a capture of the third, delight, as well.

It is to be hoped that with recognition by engineers of the contributions of architects on the side of beauty, and a corresponding recognition by architects of the contributions of engineers on the side of utility, the barriers between these two great professions will continue to disappear. Regardless of whether the first emphasis is normally placed on *utility* and *fitness* by one of these professions or on *delight* and *fitness* by the other, in the last analysis it is the individual that counts and not his title.

GAVIN HADDEN
Civil Engineer,
New York, N. Y.

Error in Weir Formula

Sir: I would like to call your attention to an error in my recent article, "Submerged Weir Formula Verified", (*ENR*, Aug. 31, p. 272.)

In the denominator of the last term of the equation for n (first line above nomenclature), there appears

$$0.886 + \frac{1.31}{P} = S.$$

This denominator should have read

$$0.886 + \frac{1.31}{P} - S.$$

GLEN N. COX
Professor of Mechanics and Hydraulics,
Louisiana State University,
University, La.

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Editorial Offices at 330 West 42nd Street, New York

SEPTEMBER 28, 1939

MUNICIPAL works administrators face a constant challenge in their task of operating the public services essential to community life. Not only does existing plant suffer from normal obsolescence and call for rehabilitation but new demands for higher standards of service accelerate the need for replacements. Better trafficways, better water quality and a host of betterments in all phases of activity are requirements in every municipality regardless of size or previous condition of its facilities. It is this continuity of needs which puts upon administrators the responsibility of being receptive to new ideas and acquainted with current developments. To help them in this endeavor professional organizations and technical journals are the prime factor in disseminating new knowledge. This issue of *Engineering News-Record*, which lays particular emphasis on municipal public works, evidences the challenging nature and possible solution for some of today's problems.

Better Sanitary Fills

NOW THAT sanitary fills are used in many cities, improved methods of filling are becoming more evident. For example, instead of putting earth over loosely dumped garbage and refuse, Portland, Ore., makes the fill in layers only 7 or 8 ft. thick, and operates a tractor at the dumping point to compact the fill before the earth cover is placed. Later settlement thus is minimized and rat infestation is practically eliminated. In Portland and elsewhere sanitary fill methods have advanced much as the technique in making earthfills has been improved.

The Waterworks Inventory

AN INVENTORY of the nation's water supply facilities is one of the big jobs that needed doing. *Engineering News-Record* is glad to announce that such an inventory has been completed and is published in this issue. Like the inventory of sewage disposal facilities (*ENR*, Jan. 19, 1939) it was compiled with the able aid of state sanitary engineers, who combed their official records and obtained new data where needed in order to supply the required information. The survey, arranged by states, includes data on the number of people and communities served by water systems, ownership of systems, sources of supply, and a detailed tabulation of treatment facilities. Thus there is now available for the first time a complete picture of the status of water supply in the United States.

Guarding Against Dust

DUST REDUCTION to the hygienically safe concentration of five million particles per cubic foot of air where men are working is being accomplished at the crushed stone plant for Hiwassee Dam. While, as the description on another page makes clear, several operations at this plant represent technological advance, the attention given to dust hazards is of chief importance. Mechanical control of dust concentration is supplemented by careful acceptance examination of workmen. To the crushed stone producer, exceptional interest lies in the dust-control equipment. The train of crushing, screening and conveying operations extending nearly half a mile multiplies the points where mechanical devices for dust control are required, but it also provides wide open spaces for safe fan discharge. The concentration of equipment at the secondary crushing plant more nearly approaches average requirements, and this plant is so simple as to indicate that it can be applied to commercial production.

A Test Case

MASSACHUSETTS has passed a law designed to eliminate the evils of bid shopping. As reported in more detail in our news pages, the law requires sub-bids to be filed with the letting authority and permits of accepting any sub-bid even though not used by the lowest general bidder; shopping around for reductions in subcontractors' prices after the award is ruled out. The obvious merits of such a system are accompanied by many disadvantages, some serious enough to threaten to disrupt fair contracting relations. The general contractor will need more time to work out his bid. will not be free to select the subcontractor with whom he can work most efficiently, will have to supervise more rigidly, and may have to bid higher in consequence. It is possible also that fewer bids will be received. The added complications are

particularly irksome on small jobs. However, the pros and cons cannot be fully weighed until after the law has had practical trial.

Emergency Transport

LOOSE THINKING about the functions of express roads is exemplified in the recent proposal that the Pennsylvania Turnpike be extended from Harrisburg to Philadelphia, allegedly to create a direct route for steel from the mills of Pittsburgh to the Navy Yard at Philadelphia. The proposal also shows how imperative is the need for integrating highway planning with national transport planning so that in an emergency both railways and highways will be so used as to make the best use of the inherent advantages of each. Bulk steel, for example, should not move by highway; it should move by rail. Without doubt there are ample rail facilities to move steel from the mills to the shipyards, but if not such facilities should be provided. Similarly, the best way to handle all major commodities—by rail, road, waterway or airplane—should be studied and a pattern laid down from which the deficiencies of each type of transport can be determined and provided.

Good Business Sense

CHANGES arising out of the war in Europe are certain to impose many strains on industry and business. Some strains have already been felt, in construction as in other industry, because of shifts in demand and price levels, but much more severe strains may be expected with the passing months. It will take alertness and good business sense of high type to adjust to these strains.

Some current happenings indicate that industry is watchful and that at least some of its elements stand ready to act with judgment and sense. The alertness of construction men is shown by the action of the Associated General Contractors in centering its board discussions next week on the problems ahead. In a broader field the National Association of Manufacturers, through its president, Howard Coonley, has obligated itself to keep product prices in close relation to production costs. Acting even more directly, the steel industry announced that its prices will continue unchanged through the fourth quarter of the year—this in the face of a sudden rush in demand.

A specially significant statement of policy was made by the Lincoln Electric Co. a few days ago. In public advertisements it pledged itself to make no increase in prices except to cover higher material and labor costs, and to pass on to its customers all economies resulting from further efficiencies. The creed thus expressed is good sense of highest type in circumstances like the present. It is a creed that if adopted by every individual and every company would safeguard the country against some of the harmful consequences experienced in earlier industrial crises.

Prudence and good sense in price policies coupled with a progressive spirit that will maintain product improvement and cost reduction can carry us through the coming difficulties without serious dislocation. If present indications truly reflect the attitude of all industry, we have reason to count confidently on this outcome.

Road Preparedness

AN OPPORTUNITY is before the state highway departments to contribute to national preparedness in the direct line of their assigned duties. The opportunity is that of undertaking immediate check and survey of the bridges on key-route roads to verify their adequacy and in case of any inadequacy to prepare plans for improvement or replacement.

Putting the country's transportation system in order for efficient service is known to have an important position in the current preparedness planning. If highway transport is to have its logical place in this planning, the roads serving key points must be fully dependable; bottlenecks and potential interruptions cannot be tolerated on main roads between industrial centers and gateway points. Sub-standard bridges are the most serious hazards of the kind, and as their improvement to standard clearance and capacity takes time it demands immediate attention.

State Highway Officials' clearances and H-15 load capacity may be taken as minimum service standards for both civil and military transportation. Bridges of lower rating, as well as those whose approaches create undue traffic risks, have first place in a program of road preparedness. If the necessary improvement plans are worked out at once, quick action will be possible whenever the word is given.

Cooperation in solving this problem is an obligation of the states, for the highway systems under their care are as much the nation's concern as their own. Since the importance of action is clear, it should not have to wait for an official call.

FIG. I. TYPICAL GRADING SCENE ON THE PENNSYLVANIA TURNPIKE.

Grading the Pennsylvania Turnpike

C. S. HILL
Associate Editor, Engineering News-Record

Contents in Brief — Contracts let for 160.8 mi. of grading in nine months. Paving contracts now being let. Heavy cuts and fills are frequent, drainage structures are many but small. Large earthmoving equipment dominates the work.

TWENTY MONTHS till completion was the brief period allowed by federal agencies in their agreement to finance the Pennsylvania Turnpike. The task was one of the heaviest ever set in roadbuilding. Between Oct 28, 1938, when the first contract was let and June 29, 1940, the turnpike engineers and contractors have to build 161 mi. of four-lane concrete divided highway including 6½ mi. of tunnels and 300 bridges and culverts. Now, at the halfway date in the time period, the engineers and contractors are confident that this work will be done. And this is indicated by the figures to be given; but a word in review is required first.

The conception of the turnpike as a means of realizing on the partly completed grading and tunneling work of the abandoned South Penn Ry., that cost the turnpike commission $2,000,000, was outlined in *ENR*, July 29, 1937, p. 175. From this time over a year was required to bring the project to the stage of actual financing and engineering design; these developments and the plan to cancel the financing obligations by collecting tolls were described in *ENR*, Jan. 5, 1939, p. 27. This article tells of progress in the first nine months of active construction.

Getting set for the task

From the first contract (Oct. 28, 1938), speed has been so great in putting more work under construction that mileages and values of work under way have increased weekly. Today this change is going on as actively as ever; the figures of work contracted taken by the writer on the ground three weeks ago have already been increased and superseded. So that the reader may have a datum from which to measure progress, a date, July 28, 1939, has been arbitrarily chosen. This is the date on which bids were received for the last 2.72 mi. of grading and drainage on the 160.8 mi. of road. The contract was awarded Aug. 1, three days later, almost exactly nine months after the first grading contract. Now the engineers have turned with equal speed to calling for bids and awarding contracts for paving, but this is the subject for a future article; here only progress in grading and drainage is considered.

All contracts have been awarded for 160.8 mi. of grading, including tunneling and drainage, totaling $32,151,963. This total includes a contract for 10.28 mi. of paving awarded

July 20 at a contract cost of $886,027, the first paving work. On the 45 contracts as of July 28, about 5,000 men were working for contractors and 1,200 men for the turnpike commission. The commission payroll amounted to $150,000 a month, and on June 30, the last preceding monthly estimate, the contractors had been paid $3,131,715. On July 31 the value of the work completed was estimated to be $6,035,598; based on an estimated construction cost of $49,000,000 this is 12.3 per cent of the work. But care should be taken not to assume this percentage as the rate of future progress for the period up to Aug. 1 was a period of contract letting; over a score of the contracts were not awarded until June and July yet on July 28 an average of 50 per cent of the work had been completed on 30 contracts. From the construction viewpoint, then, the nine months to July 28 were a period of getting set for construction, and this of course is only for grading, tunneling and drainage structures; paving as a whole has only begun to be organized.

The work to be done

Omitting paving, what is the work being done? Briefly, it is moving 21,000,000 cu. yd. of earth and rock or an average of 136,000 cu. yd. a mile; completing eight partly finished old tunnels of the South Penn. Ry., totaling 6½ mi. and requiring 7,000,000 cu. yd. of excavation; and building about 300 bridges and culverts for drainage and grade separation.

In the open, a 78-ft.-wide grade is being constructed on a 200-ft. right-of-way; in tunnels the roadway width is reduced to 28 ft. Further details of roadway, cut and fill, and grade and line design can be found in the preceding article, *ENR*, Jan. 5, 1939.

Generally the grading and structures are contracted in short sections running from $150,000 to $900,000 in cost and averaging perhaps $500,000. Two 7½-mi. sections run upward of 1½ million dollars but these are the only grading jobs on this line that exceed $1,000,000. Contracts of moderate size, thus distributing the work among many contractors, were planned to speed the work. Tunneling contracts run from 1½ to 3 million dollars; these are left for discussion at another time. But all the grading contracts except a few are large enough to warrant large equipment investment, as is noted farther on. And

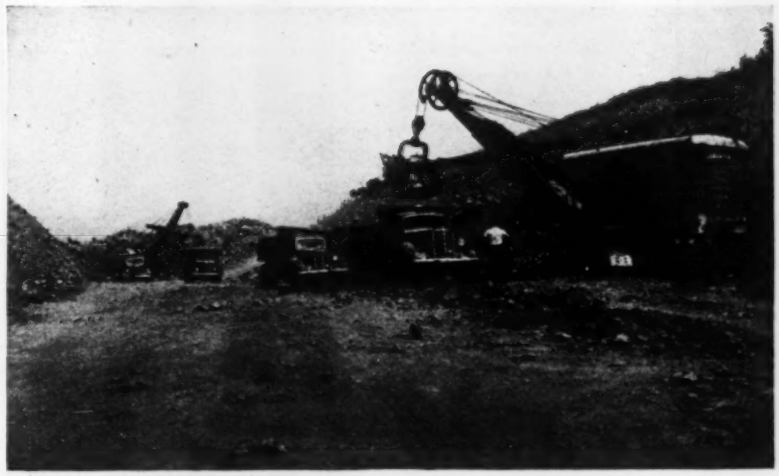

Fig. 2. The power shovel holds its place as an essential excavating unit but now it is a diesel-powered, crawler-mounted machine loading motor trucks.

Fig. 3. Standard outfits for rock excavation are wagon drills using air from portable compressors.

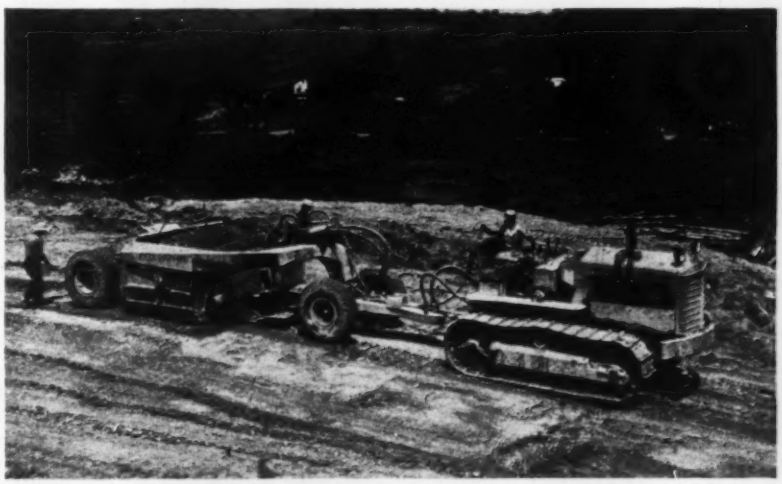

Fig. 4. Great 12 to 20-yd. scrapers hauled by 95-hp tractors dominate many miles of the grading operations.

Fig. 5. The rooter has freed many miles of hard excavation from blasting.

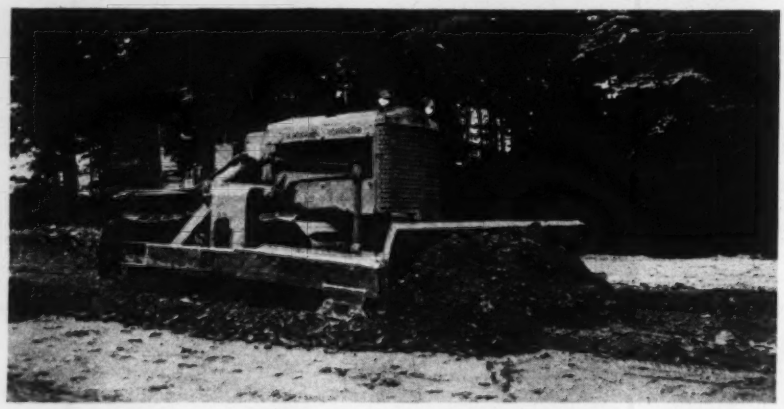

Fig. 6. Bulldozers have proved one of the most useful machines in smoothing down the rough grade to contract requirements.

some of the operations are truly heavy work, as a few examples will show.

Many deep cuts

The largest cut on the turnpike (and in Pennsylvania) through Clear Ridge Mountain near Everett, Bedford County, is 150 ft. deep at the crest, 380 ft. wide, and 2,600 ft. long. More than 1,130,000 cu. yd. of earth and rock will be excavated. Next to the Clear Ridge cut in size is a cut 106 ft. deep and 800 ft. long shearing through Mt. Dallas ridge southwest of Everett. Since much of this cut will be in solid rock the sides will be sloped 1 on ¼, giving a width of 184 ft. at the top. The excavation required here will be 1,115,000 cu. yd.

The third largest cut on the line is near Mount Joy, Westmoreland County, and is 97 ft. deep, and nearly 300 ft. wide at the top, with about 500,000 cu. yd. of excavation. Other big cuts in this county include one 50 ft. deep, and 1,760 ft. long near Donegal, and another 48 ft. deep and 2,600 ft. long near Long Hill. A 60-ft. fill 1,000 ft. long is located near Jacobs Creek, and 76-ft. fill, 2,400 ft. long will carry the turnpike over a township road, near Mount Joy.

In Somerset County, two cuts replace abandoned South Penn tunnels. An 83-ft. cut 1,250 ft. long replaces Quemahoning tunnel, and Negro Mountain tunnel is bypassed to the south by a 67-ft. cut 1,500 ft. long. The turnpike enters Somerset County from the east through an 80-ft. cut adjacent to a 78-ft. fill, 1,422 ft. long near Three Lick Run, then passes over a 70-ft. fill and through a 95-ft. cut near Wambaugh Run. The line approaches Allegheny tunnel by a 60-ft. cut, and there are two other cuts of the same depth, one 1,250 ft. long at Laurel Hill Creek, the other 1,700 ft. long near the Laurel Hill Tunnel. There is a 55-ft. cut 950 ft. long near Clear Run.

Bedford County, where the turnpike descends into the Juniata River valley, provides some of the heaviest excavation work on the entire route. Near Brush Creek is a 65-ft. cut half a mile long, and nearby another long cut 58 ft. deep. Just west of the big Clear Ridge cut is a cut 50 ft. deep and 2,300 ft. long. At Earlston is a 55-ft. cut near a 55-ft. fill 1,000 ft. long; an 80-ft. fill 650 ft. long on Brush Creek, then two 55-ft. fills and several cuts and fills more than 40 ft. deep. The heaviest work in Fulton County is a 35-ft. cut 1,200 ft. long just west of Tuscarora tunnel, at Nine Mile Run a 47-ft. fill and at Ten Mile Run a 42-ft. fill.

Without being a complete count of heavy grading operations, these examples indicate clearly the need of the powerful earthmoving machines that dominate the turnpike work.

Safety precautions

In all operations, rather unusual precautions are taken to safeguard against rock falls and slides. Sides of cuts generally are sloped 1 on 2 and where more than 50 ft. deep are terraced or benched. Diversion ditches are run along the tops of deep cuts, and along the benches to prevent surface water from washing material down onto the roadway. A 3-ft. drain is provided at the sides of the road in cuts. Fills are thoroughly rolled in thin layers and the high fills will be allowed to settle during the coming winter before the roadway slab is laid over them. In some places, the already-settled South Penn Ry. fills will form the hearts of turnpike fills, being "tied in" by benching and other means. Sides of fills are sloped 1 on 1½. Excavated material, wherever possible, goes into fills.

Small drainage structures

With few exceptions, the drainage structures that go into the grading contracts are not large. This is largely due to line location. The turnpike follows in general a highland location. Though excavation costs are somewhat increased by this route, structure costs are correspondingly reduced. Streams are more numerous in the highlands than in the valleys but they are smaller, and most of them can be bridged by box or arch culverts. Of the 130 drainage structures, only 29 are over 25 ft. and only 14 are over 50 ft. in span. Even so, it was found necessary to build several viaducts and other major structures, of which the 600-ft. New Stanton viaduct in Westmoreland County is the largest. This imposing structure of reinforced concrete will span a 1,400-ft. valley 60 ft. above the valley floor, and will

Fig. 7. Blade graders and rollers put the final finish on the grade before the paving contractor takes over.

carry the turnpike over two highways, a railroad and Sewickley Creek. Second in importance is the 500-ft. Juniata River bridge, in reality a viaduct, near Bedford. Another viaduct, this one 425 ft. long, will cross Dunnings Creek not far from the Juniata viaduct.

A heavy equipment job

Not only the heavy excavation and fill but the short construction period allowed called for the heaviest types of equipment. In the largest aspect, this is the distinguishing feature of the grading. The details of each contractor's operations are in comparison insignificant and in fact they commonly are usual practice. But every contractor has gone in for machines and about the biggest machines that can be had. This is more particularly true of the tractor carryall-scraper, rooter and bulldozer outfits than it is of power shovels. Some 75 per cent of the grading is possible without blasting. But so much is possible only because of the power of the modern scraper, bulldozer and rooter outfits. On the turnpike, these machines are handling material that only a very few years ago would have requisitioned the drill runner and blasting expert.

All of the excavation, however, is not within the capacity of power excavators; some of it, and particularly a silicious sandstone, is about as hard as anything that ever dulled a drill bit. Wagon drills served by portable compressors are common equipment for the rock work. Incidentally, the silicious rock has led the turnpike engineers to require dust control methods as a health measure, particularly in the tunneling. As Pennsylvania has no governing law, New York regulations are being followed.

Any cataloging of equipment is uncertain because probably no one knows how many machines have been put on, taken off and shipped about the work as early contractors finished and recent contractors began operations. At any rate, the numbers run into scores for power shovels, scrapers and wagon drills and into hundreds for tractors and hauling equipment. One estimate of a good observer who traveled the grade line is that the equipment new would cost $10,000,000.

But the outstanding equipment characteristic is size and power. A few examples will demonstrate: (1) Mount Joy cut, 2-yd. diesel shovels load 12-yard diesel trucks; (2) 1¾ diesel shovels load units of 14-yd. wagons pulled in tandem by 95-hp diesel tractors; (3) 2-yd. diesel shovel loads 5-yd. four wheel drive trucks; (4) 101-hp diesel tractor 10-yd. carryall type scraper units with pusher tractor for loading; (5) self-powered elevating grader pulled by 95-hp tractor loads 12-yd. tractor-trailer units; (6) tandem 15 and 12-yd. scrapers pulled by 95-hp tractor, 95-hp pusher-tractor helps load; (7) 30-yd. scraper pulled by 95-hp tractor, 95-hp pusher tractor helps load. This list could be doubled or trebled but little but numbers would be added to the picture of powerful earth moving machinery in operation. In general, grading contractors have worked three shifts a day, lighting the work at night. The men work a 40-hr. week; wages run from 53½c. to $1.40 an hour.

All work is being carried out by contract under the Pennsylvania Turnpike Commission, Walter A. Jones, chairman, and Samuel W. Marshall, chief engineer, Harrisburg, Pa.

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Timber Treatment Declines

The total output of treated timber for 1938 was about 8 per cent below that of 1937, and the decrease occurred in all classes of timber, according to the annual report of R. K. Helphenstine, Jr., of the U. S. Forest Products Laboratory. The main figures were as follows: bridge and miscellaneous timber and lumber, including plank, wood blocks, posts, and mine ties and timbers, 367,542,708 ft. b.m.; switch ties, 105,352,119 ft. b.m.; crossties, number, 44,598,678; poles, number, 3,545,077; piles, 12,751,961 lin.ft. nearly 96.5 per cent of ties and switch ties were creosoted, and 79 per cent were adzed or bored, or both, before treatment. Of the poles, 73 per cent were pressure-treated and 23 per cent butt-treated; 98.4 per cent of the poles and nearly all piles were creosote-treated.

Removing Columns from a Tall Building

ROBERT G. LOSE

Structural and Architectural Engineer, Atlanta, Ga.

Contents in Brief—In modernizing the Ansley Hotel in Atlanta, Ga., a 13-story reinforced-concrete structure, it was necessary to remove the first-story portions of two columns. Steel-girder-and-column bents were installed to pick up the loads at the second story, transfer of load between concrete column and steel girders being through a steel plate jacket equipped with lugs that fit into sawed chases in the concrete.

PRESENTED with the problem of enlarging the banquet hall facilities of the Ansley Hotel, Atlanta, Ga., the architect decided that the greatest improvement could be achieved by removing two columns in the existing room. One was a wall column and the other, directly opposite, was in the first interior line of columns. The building is a thirteen-story reinforced-concrete structure resting on caissons carried to rock. The writer was consulted by the architect on the practicability of removing the first-story portion of the columns in question, on the probable cost, on the space required for the necessary support, etc., and was given the commission to prepare the design.

Back in 1930, the writer had the problem of removing some seventeen steel columns in the Citizens and Southern Bank Building in Atlanta to make way for a new banking room. In that work the principle of placing the permanent supporting girders before removing the columns was used. This method eliminates most of the cost and hazard of shoring and is carried out by placing a girder on each side of the column to be removed, deflecting the girders the figured amount, and attaching the girders to the columns. It was decided to use this idea in the design to be prepared for removing the two concrete columns of the Ansley Hotel.

Fig. 1 shows one of the girders in place before the lower part of the column (shown coming through the center of the girder) was removed. Spacing of the columns was 14 ft. 10 in. on centers so that the girder is something over 30 ft. long. It will be noted that the end of the girder is supported on a battened steel column set against the face of an existing concrete column. This steel column rests on a steel grillage spanning between the caisson directly under it and the caisson under the next column 14 ft. 10 in. to the right.

Fig. 1. Steel-girder-and-column bent in place ready to pick up column load at its center. Concrete column projecting below girder will then be cut off.

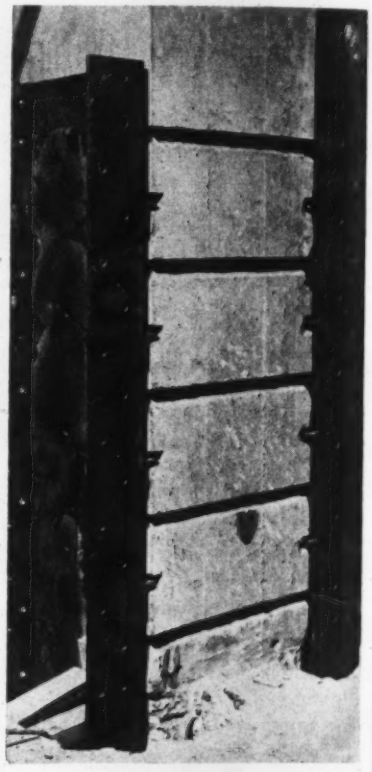

Fig. 2. Installing steel boot around concrete column which has been rabbeted to receive load transfer lugs. This view is on second floor. Supporting girder will be attached to the boot at ceiling level of first floor.

The principal problem was to develop a method of transferring the load in the concrete columns to the girders or to some intermediate member that could be attached to the girders. The columns, about 2½ ft. square, were heavily reinforced, hav-

ing, besides the vertical bars, both spirals and hoops, with some of the vertical bars in the corners outside the spirals and inside the hoops. The estimated load on the wall column was 640,000 lb. and on the interior column 880,000 lb.

Column-girder connections

It was decided that it would be impractical and dangerous to drill through the columns for sufficient pins to take off the load, and that, therefore, it would be necessary to develop some kind of a positive surface friction. It was found that the surfaces of the columns could be rabbeted to a depth of 1 in., the total of the vertical areas thus formed being sufficient to take the load from the column without over-stressing the concrete. The rabbets had to be spaced so that the part of the load considered on each rabbet would be transferred to the body of the column at a safe shearing stress for the concrete.

It was found also that, in addition to the length of the columns between the girders, a considerable additional length of the columns had to be used for contact. This made it necessary to contact the columns in the second story also. Some existing floor beams in the building were also wedged into use, and their value considered.

Fig. 3. Placing grout through holes in steel boot to make tight contact with concrete column.

The load transfer device chosen was termed a "boot" and consisted of steel plates contacting the four faces of the column and tied together at the corners with four angles. Bars and angles were welded to the plates to fit into the rabbets. The bars were used on the plates contacting the first-story columns and angles on the plates contacting the second-story columns where the column reduced in size and the distance from the plate to the surface of the column was increased. The boots were to be grouted on the columns after being adjusted to place.

Fig. 2 shows the rabbets in the second story of the wall column with two plates of the boot in place. The vertical line of holes at the center of the plate are for grouting. Note that these holes are just above the bars and angles welded to the plates.

The girders are made up of a web plate and a flange, on one side only, consisting of an angle, a side plate and two cover plates. This type of girder is used so that the boot can be bolted directly to the girder, requiring the load to pass through only one set of bolts. Driven rib bolts were used for all field connections in place of rivets.

Sawing the concrete

It was specified that the rabbets should be cut with carborundum saws. The contractor started the cutting, making two cuts for each rabbet, one for the top, and one for the bottom, and chipping out the fins between the cuts. This proved to be so expensive that only the top saw cut was continued, and the rabbet formed by undercutting. So long as the top of the rabbet formed a square shoulder to take the load, the design did not require the bottom of the rabbet to be square.

Fig. 3 shows the grouting being done. The pipe from the bottom of the funnel has a right-angle bend and is screwed into a tapped hole in the plate. There is a union on the pipe to facilitate the changing of the funnel from one hole to another. A much-used plumber's tool was found very useful to keep the grout agitated and flowing. The grouting was started at one of the bottom holes in the boot, men being stationed to watch the holes in the plates on the other three sides. As the grout traveled around the column and came up to a hole, a plug was screwed into the hole. The operation was moved around the column to keep the grout coming up evenly on all four faces. By inspecting through the holes it was possible to keep track of the position of the grout on all sides and to assure that all sides were completely filled.

Fig. 4. Job of supporting the columns is finished and workers are cutting away the first-story portion.

Deflecting the girder

After the assembly was completed, as shown in Fig. 1, and the grouting finished, the girders were deflected the figured amount by raising the steel columns at each end. With the aid of wires stretched underneath each girder and attached to the girders and passing over scales glued to each of the three columns, the simultaneous lifting of each column could be controlled and the deflection of the girder could be measured. The lifting force consisted of a group of wedges assembled under each column just above the footing grillage.

Fig. 4 shows one of the columns being cut out. The girders had been fireproofed but the column could just as well have been cut out before this finishing work was done.

George H. Bond was the architect, Ralph W. Didschuneit was contractor, and the steel fabricator the Calvert Iron Works, all of Atlanta.

FIG. 1. SULPHUR CREEK FILL LOOKING WEST INTO ONE OF THE DEEP CUTS OF THE SOUTHERN END.

Rail Relocation Around Shasta Reservoir

***Contents in Brief**—The Southern Pacific railroad line north of Redding, Calif., is being relocated to take it out of the valley to be flooded by Shasta Dam. Factors affecting the selection of a route outlined. Bureau of Reclamation to bear all construction cost and share in maintenance costs during the seasoning period.*

BUILDING the new main line of the Southern Pacific railroad across the hills bordering Shasta reservoir to replace that portion of the present line in the Sacramento River canyon that will be flooded out, is a $17,500,000 job involving unusual conditions. The U. S. Bureau of Reclamation has undertaken to provide the railroad company with a new route that will, despite heavy grading and numerous tunnels and bridges, be equivalent to the present low-level route. Just what share of the higher cost of the new line resulting from higher construction standards should be allocated to the bureau and what share to the railroad company, presented a difficult problem. This question was settled by an agreement under which the bureau builds and pays for the new line and agrees to repay part of the maintenance costs of the first five years.

Construction under supervision of the bureau commenced in October, 1938, and nearly all the work had been contracted by August, 1939, except the Pit River bridge on which bids are to be called this fall. Completion of the new line is expected by September, 1941. Meantime, so that railroad operation in the canyon at the dam site need not interfere with construction operations, trains are using a bypass tunnel driven through the west abutment.

Despite the fact that the present route was located almost 60 years ago it still has advantages over any substitute line. For example, double tracking would not be expensive and operation and maintenance costs are relatively low. Had it not been for the Central Valley project the railroad doubtless would have remained in the canyon indefinitely.

East versus west side

When construction of Shasta Dam made it necessary to get the railroad out of the canyon, the first question was whether it should be put on the east or the west side. The fact that the existing rail line is on the west side of the river and remains there above and

TABLE I — COMPARISON OF COSTS ON NEW ROUTE WITH COSTS ON PRESENT LINE

1. Train operation and maintenance of equipment	$59,370 less	
2 Maintenance of way (exclusive of depreciation)	20,811 more	
3. Depreciation (Replacement of bridge steel and structures)	40,200 more	
4. State taxes	39,000 more	
5. Normal annual loss on new line (Algebraic sum of 1, 2, 3 and 4)		$40,641
Normal annual loss capitalized at 4 per cent		1,016,025
6. Abnormal costs during seasoning period		685,526
7. Value of new ties, rails, etc., in relocated line versus items of partially expended life on existing line (a credit item)		247,249
8. Increased cost of future second track as compared to second track cost on present route		7,248,188

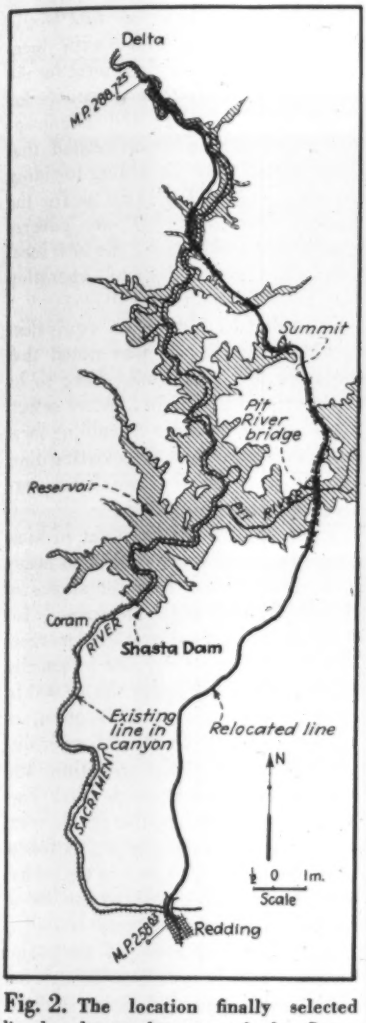

Fig. 2. The location finally selected lies largely to the east of the Sacramento River.

below the reservoir site favored putting the relocated line on the west. Early studies were based on the expectancy that the best route would be found on that side, but it was found that the west side involved rougher country, longer tunnels and more difficult grading than did the east side. On the east side, however, bridges were generally longer and higher. Finally the east side, despite its $6,000,000 Pit River bridge, for which there is no counterpart on the west side, was chosen as clearly the better. Seven reasons supported this decision.

(1) The best route found on the west would have necessitated three long tunnels (9,400, 7,600 and 7,070 ft. respectively). Operation of freight and passenger trains through such tunnels was rated as bad because of smoke and gas nuisance. This applies particularly to a single track line on which train movements would be in both directions.

(2) Because of topography and location of the long tunnels, sidings necessary for effective single-track operation could not be obtained at reasonable cost.

(3) Hillsides denuded of vegetation by smelter fumes as they are on the west side, are subject to erosion in the heavy rainfall of this region. Attendant hazards would be chocked culverts and overflowed track. (There is no denudation in the territory traversed by the east side location which is out of the canyon.)

Fig. 3. Terrain typical of the 16 mi. north of the summit. Cut just started in background will be 95 ft. deep and the fill on the near side of it, 100 ft. high.

TABLE II — CONTRACTS ON RAILROAD RELOCATION AROUND SHASTA RESERVOIR

Item	Contractor	Amount bid (dollars)	Date contract awarded
Railroad diversion tunnel	Colonial Construction Co. (Spokane, Wash.)	426,475	June, 1938
Foundation, 1st Sacramento River crossing	Clifford A. Dunn (Klamath Falls)	173,120	Sept. 9, 1938
Superstructure, 1st Sacramento River crossing	American Bridge Co. (Pittsburg, Pa.)	569,100	Sept. 9, 1938
First 13 mi. of grading north of Redding. (MP. 258.63 to 271.13)	Granfield, Farrar & Carlin (San Francisco)	812,380	Nov. 2, 1938
Next 1½ mi., including tunnels 1 and 2. (MP. 271.13 to 272.68)	West Construction Co. (Monrovia, Calif.)	904,981	Nov. 2, 1938
5 mi. of grading and tunnels 3, 4, 5, 6 and 7 (MP. 272.68 to 278.55)	A. Teichert & Son, Inc.; United Concrete Pipe Corp.; Ralph A. Bell (Los Angeles)	1,857,567	
4 mi. of grading and tunnels 8, 9 and 10. (MP. 278.55 to 282.60)	R. G. Clifford	1,223,186	May 22, 1939
5 mi. of grading and relocating 2½ mi. of U. S. Highway 99 (MP. 282.60 to 287.81)	Granfield, Farrar & Carlin	286,900	April 6, 1939
Grading, tunnels 11 and 12 structures in junction near Delta, substructures for 3rd and 4th Sacramento River crossing (MP. 287.81 to 288.73)	United Concrete Pipe Corp. (Los Angeles)	598,673	Dec. 16, 1938
3rd and 4th crossings of Sacramento River	American Bridge Co.	124,337	Dec. 16, 1938
Doney Cr. Bridge and 2nd Sacramento River crossing			
Substructure	Clifford A. Dunn	344,780	May 25, 1939
Superstructure	Bethlehem Steel Co. (San Francisco)	294,365	May 25, 1939
Substructures for bridges over O'Brien and Salt Creeks	Heafey-Moore Co., and Frederickson & Watson Const. Co. (Oakland, Calif.)	284,517	Sept. 20, 1939
Salt Creek Bridge superstructure	American Bridge Co.	218,675	Sept. 20, 1939
O'Brien Creek Bridge superstructure	Bethlehem Steel Co.	172,130	Sept. 20, 1939

Bid prices do not include materials for completed structures, such as cement, steel, pipe, metalwork, machinery, etc., except in bridge superstructure contracts.

Fig. 5. Terrain typical of the 14 mi. south of the summit of the new railway line.

(4) Mountain slopes and drainage basins extend to higher elevations on the west than on the east, thus entailing risk of larger floods made more serious by the heavy debris content from denuded areas.

(5) Many of the fills on the steep slopes of the west side location would extend below reservoir level creating future difficulties of maintenance and making original construction uncertain.

(6) Accessibility for construction purposes on the west is not as good as on the east side location, which is adjacent to the state highway.

(7) Finally, comparative estimates showed the west side location to be more expensive than the east side in first costs.

The next question was the allocation of cost between the bureau and the railroad company. The latter holds that the relocated route will be much more expensive to maintain than the present line, so much so that annual cost increases will offset operating savings on a line built to modern standards and almost 20 per cent shorter than the old route. (The new line, 30 mi. in length, will replace 37 mi. in the canyon.)

Before reaching this conclusion an exhaustive comparison of old and new routes was made in connection with detailed operating studies. On the new line, longer tunnels, deeper cuts and fills with their abnormal maintenance costs during the seasoning periods had to be taken into account. In making these comparisons the Southern Pacific, from whom these data were obtained, showed that a more costly line built to higher construction standards does not necessarily result in lower annual costs.

Features of the new location

Trial lines were run on the east side to find the shortest and best route through rough country which requires some fairly long tunnels and much heavy grading. The location has the advantage of being practically on top of its drainage basin. Surveys showed that curvature and grade could be held to present-day operating standards and a line could be so located as to meet the requirements that the railroad had laid down in advance. These called for (a) a new line that would handle the train loads with locomotives of the same class used on the existing line (despite the necessity for greater total climb); (b) alignment and curvature so compensated that the elapsed time in siding-to-siding capacity will be the same as for the present line and (c) no adverse grades that would make the new location more restrictive of operation than the existing route.

In order to obtain an equivalent operating facility it was noted that the relocated line would have to be on improved alignment. After selecting alignment, grades and siding locations that equalled the existing line, annual costs on the two lines were analyzed and compared.

From the railroad's point of view a new line is always subject to heavy maintenance cost because slopes of cuts and fills are "unproved" for some years and unforeseen emergencies of an unseasoned line jeopardize train schedules. Finally the 19,000 ft. of tunnel on the new location, as against 4,000 ft. on the old, offer disadvantages in both operation and maintenance. On a single-track line, long tunnels may require special ventilation when passenger trains follow heavy freights. Also, rail in tunnel has only one-half to one-third the life of rail on open track.

Table I gives some of the major items of cost comparison though not all because many items are indeterminate; e.g., losses resulting from schedule disruptions occasioned by slides and loss of revenue on the old line (estimated at $181,000 per annum). In recognition of these conditions, therefore, and in addition to providing the railroad company with 30 mi. of new railroad as compensation for the 37 mi. to be flooded out, the Bureau of Reclamation recognizes that "deferred maintenance" will be involved in unseasoned cuts and has

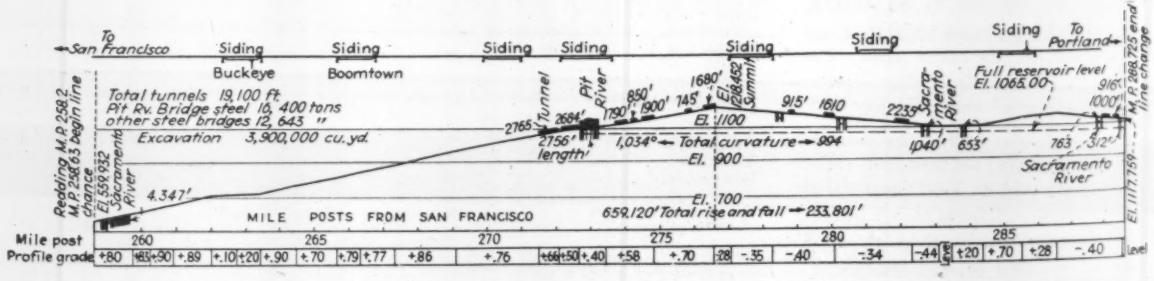

Fig. 4. Profile of the 30 mi. of new location of the Southern Pacific railroad line around Shasta reservoir.

agreed to compensate for these costs as they occur, up to a maximum of $350,000 in a 5-yr. period.

The Pit River bridge

When the location on the east side of the reservoir was selected, a high bridge over the Pit River arm of the reservoir became a focal point. The location for this structure was fixed by (1) topography, (2) the desirability of making the bridge serve railroad and highway jointly, and (3) geological formations affecting foundation. All three were met by a crossing 14 mi. north of Redding, estimated to cost about $6,000,000.

At this location plans call for a bridge nearly 3,000 ft. long including a cantilever span of 630 ft. and two 492-ft. anchor spans plus approach trusses and girders of various lengths. Main piers are of monumental proportion with a height of 380 ft. above foundation. In the design of this bridge careful attention was given to making it earthquake-resistant, so far as was economically feasible.

The bridge will be a double-deck structure with the railroad below and the highway above. The highway (U. S. No. 99) will be 44 ft. wide with 2½-ft. walkways on either side and will be about 500 ft. above the bottom of the ravine. Construction time is estimated at about 21 months. This estimate assumes access to both ends of the structure toward the close of the construction period.

The width required for highway on the upper deck, together with the great height and length, made it desirable to lay double track on the railroad at the outset. On other bridges of the line, however, only portions of concrete piers which are below normal reservoir water level, and therefore difficult of access later, will be built to double-track width now.

The Pit River bridge is to be built by the Bureau of Reclamation and then turned over to railroad and highway authorities for joint operation. Agreement is yet to be made between these two agencies as to the allocation of maintenance costs. Also, the question as to responsibility for replacement in the advent of damage to the structure by earthquake or other outside cause has not yet been settled.

Heavy grading involved

The old main line that will be submerged follows the winding river channel with a total of 7,129 deg. of curvature, using curves of 10 deg. 30 min. The new line will be 7 mi. shorter, total curvature will be reduced to 2,015 deg., maximum curvature will be 4 deg. and maximum grade 0.9 per cent, compensated, as against 1.0 per cent, compensated, on the old line. The summit of the new line is 100 ft. higher than on old line.

The new line involves some very deep cuts and fills. Fill material is spread in layers, the required moisture for maximum compaction is added and tamping rollers are used where necessary to supplement the excellent compaction resultant from the hauling and turning of large capacity carrying scrapers.

Construction started on the relocated line near Redding, the easiest point of access, whence there are no serious difficulties as far as the Pit River bridge. Grading on this section has been done by large earthmoving units, including 25-cu. yd. carrying scrapers. On parts of this contract, material has moved from cut to fill and received the necessary compaction at record rates. Where hauls were short so that round trips could be made at the rate of eight per hour, each 25-cu. yd. unit (tractor and scraper, operated by one man) excavated, moved and compacted 200 cu. yd. per hr. On the 14 mi. between Redding and the Pit River bridge, where the total excavation amounted to about 1,740,200 cu. yd., the bid price ranged from 20c. to 49c. per yd.; the charge for overhaul, (beyond 500 ft.) ranged from 0.3c. to 0.4c. per cu. yd. per station. On grading of the next 5 mi. of the line the low bid was 20c. per cu. yd. with no distinction between "rock" and "common" classifications. Trackwork, signals and minor structures will be put on the new line by railroad company forces and costs will be charged to the bureau.

Construction of the new line is being done by contract for the Bureau of Reclamation, R. F. Walter, Denver, chief engineer. Walker R. Young, Sacramento, is project engineer, Ralph Lowry is resident engineer at Shasta Dam and Roy M. Snell is in charge of the railroad relocation. Work done by the bureau includes everything except ties, rails and signal system which the railroad is to put in and bill the bureau at cost plus 10 per cent. Supervision for the Southern Pacific is exercised by W. H. Kirkbride, chief engineer; J. A. Given is location division engineer at Redding.

Tidal Wave in Hurricane Reached 17-Ft. Height

A tidal wave height of 17 ft. was observed at the Brenton Point, R. I., Coast Guard station during the New England hurricane of Sept. 21, 1938. This is the maximum rise found in a compilation of records of tidal waves in that hurricane by Frank Neumann, chairman of the tidal wave committee of the American Geophysical Union. Data were supplied by the Corps of Engineers, the Coast Guard, the Coast and Geodetic Survey, various state organizations and others, producing a total of some 65 records from the regions affected.

Brenton Point faces the open sea at the entrance to Narragansett Bay; 25 miles to the east across Buzzards Bay and Vineyard Sound, a rise between 15 and 20 ft. was observed at Gay Head, Martha's Vineyard. Figures nearly as high were reported from many other places. In the lower part of Buzzards Bay, a 9-ft. rise was observed at Cuttyhunk, Mass., while at the head of the bay near the entrance to Cape Cod Canal the water piled up to something over 14-ft. rise. A rise of from 13 to 14 ft. was also reported from Providence at the head of Narragansett Bay.

East and west of this region the rise was generally smaller, except for Nantucket, which reported about 15-ft rise. In the Cape Cod area the farthest east Coast Guard station, Monomoy Point, reported a rise of 12.5 ft. At New London, Conn., the rise was 9 ft.

Generally comparable levels were observed on the north and south shores of Long Island, with rises of 10 to 12 ft. along the barrier beaches of the south shore and 10 to 14 ft. in the coves west of Eaton's Neck, on the north shore.

Generally, the tidal rise reported was in the form of a steady encroachment of the sea on the land, except a few cases where periodic swells with 1- to 3-minute intervals were observed.

Rigid Frame Superstructure On Pontoon Bridge

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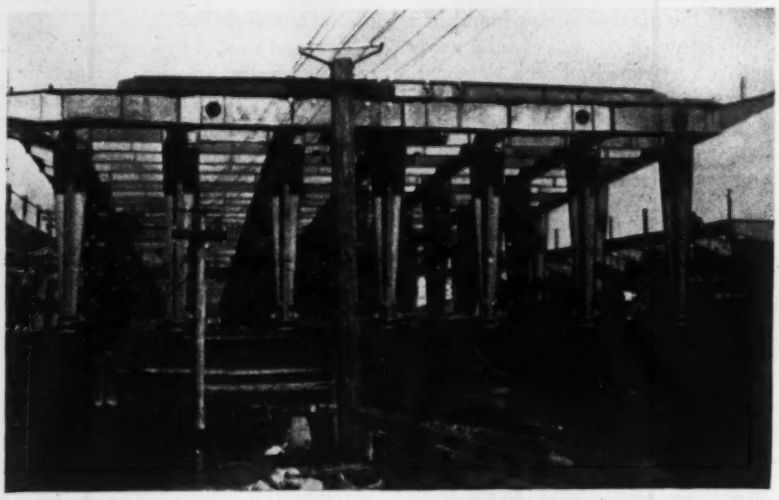
Robert College, Istanbul, Turkey

AN UNUSUAL steel pontoon highway bridge has just been completed across the Golden Horn at Istanbul, Turkey, where water depths of 65 to 130 ft. and a bottom of soft clay at least 100 ft. deep preclude economic construction of foundations. Some 1,500 ft. long and 82 ft. wide, the bridge consists of two end sections of 10 pontoons each and a center section of 4 pontoons designed to be moved out of position by tugs to permit passage of large vessels between the hours of 2 and 4 a.m.; the movable section swings open like a gate, one corner being hinged to the fixed end section. The bridge is connected to the shore at either end by simple truss spans hinged to the pontoons and sliding on the abutments.

Pontoons, of steel box construction, measure 82 x 30 ft. in plan and are 11 ft. deep in the end sections of the bridge and 12.5 ft. deep in the movable center section. The pontoons, spaced about 30 ft. apart, support a rigid frame superstructure, which is the novel element of the bridge. The 52-ft.-wide deck, with tramway tracks in the center, is a concrete slab surfaced with wood block. There is a 15-ft. sidewalk cantilevered on either side.



Pontoon bridge at Istanbul, Turkey. View at top shows the rigid frame bents spanning between pontoons. End view at bottom shows a typical six-span transverse bent except for the holes in the webs of the girders, which are for pins that connect the movable center section of the bridge to the fixed end sections.

Seven rigid frame bents are used in the direction of the axis of the bridge and two at right angles on each pontoon. These rigid frames are continuous over the ten pontoons of the end sections and over the four pontoons of the center section. The columns are built-up tapered members, the section being in the shape of a cross. Built-up plate girders constitute the floorbeams and the top members of the frame. The general arrangement of the framing is shown in the accompanying illustration.

The action of the rigid frames to distribute loads to more than one pontoon is held to be similar to the action of the stiffening truss of a suspension bridge in distributing load along the cable. With the pontoons, however, there is the added advantage of less load to distribute because of increased buoyancy as the pontoons sink.

The pontoons, fabricated of riveted steel, were constructed in a shipyard, launched and towed to the site, where the superstructure was added in a yard at the end of the bridge. Each pontoon is divided into nine water-tight compartments, and the immersed part of the hull is covered with an arsenic paint. Pontoons are held on alignment in the bridge by four mushroom anchors weighing from 1½ to 2½ tons each. The anchor chains are fastened close to the ends of the longer sides of each pontoon and dip at an angle of about 45 deg. up and downstream.

In case of damage to a pontoon, it may be removed for repair, two spare pontoons being moved into the openings on either side of it to provide temporary support for the superstructure. Columns, being bolted to their forged steel bases on the pontoons, are easily disconnected and, by pumping water into the damaged pontoon, it can be lowered enough for removal; or water can be pumped from the spare pontoons which will raise the superstructure free.

The bridge was designed by M. Pigeaud, head of the department of highways and bridges of France.

FIG. I. QUARRY FOR AGGREGATES AT HIWASSEE DAM WHERE BOTH CRUSHING AND DUST CONTROL BEGIN.

Unique Rock Crushing at Hiwassee Dam

***Contents in Brief**—By means of an elaborate dust-collecting system a highly silicious rock is being converted into concrete aggregates without health hazard. One train of crushers produces sand and four stone sizes. Stone is sized by screens and sand is graded by hydraulic classifiers. Quarry worked with 9-in. holes and nitramon as the explosive.*

HIWASSEE DAM of the Tennessee Valley Authority in North Carolina presents claim to one of the most complete aggregate production plants built for field operation. Separated aggregate in five sizes including sand is produced from a metamorphosed sandstone having a quartz content of about 65 per cent. Exceptional plant provisions are therefore made to control silica dust as a health hazard. A second exceptional feature is the combining of secondary crushing and sand manufacture in one train of operations in a single building. A separate screening plant and a hydraulic sand classifier separates the combined crusher product into sand and four stone sizes and deposits them in five stockpiles. The flowsheet of aggregate movement from quarry to mixing plant is shown in Fig. 2, and is followed in the description except that dust control is considered separately.

A quarry was opened on the west bank of the Hiwassee River about ½ mi. downstream from that end of the dam. Development conditions are exceptionally good: the rock breaks with a vertical face (now about 180 ft. high), a long face is practicable (now about 750 ft.) and the rock breaks with very little waste. A not-

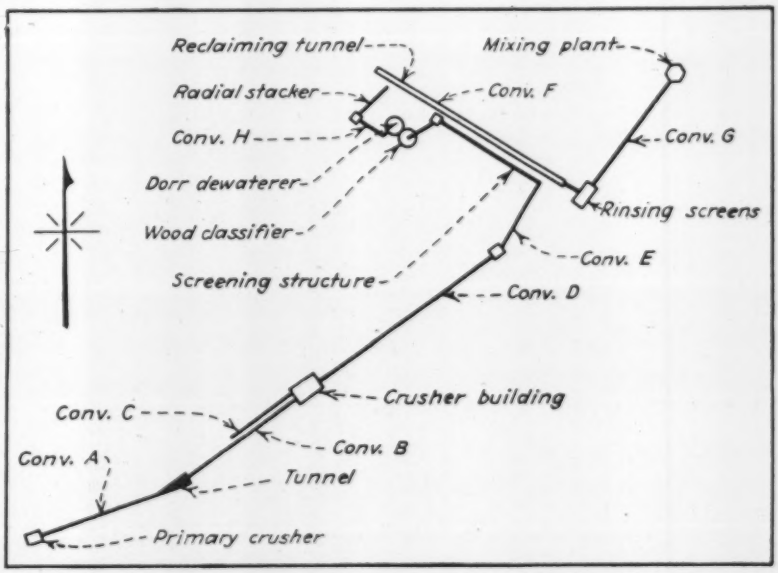


Fig. 2. General flowsheet of aggregate-production operations from quarry to concrete mixers.

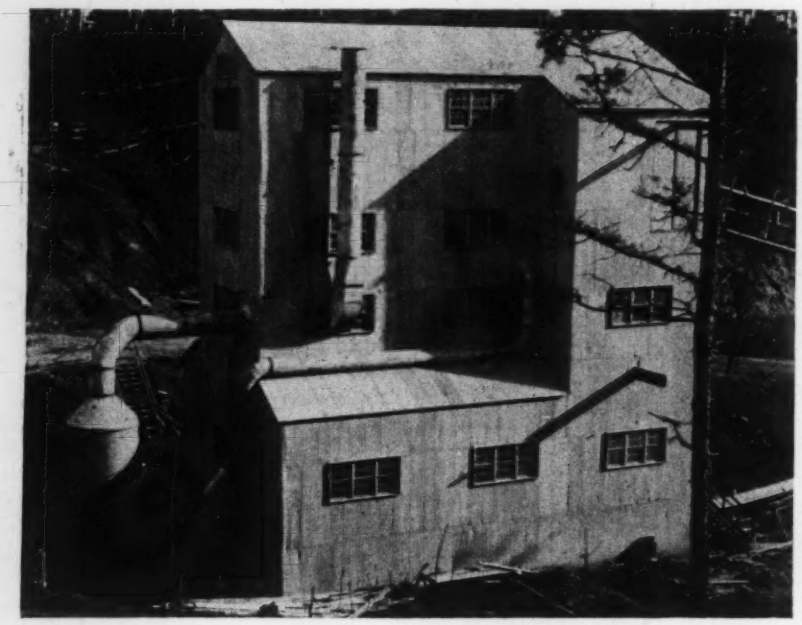


Fig. 3. Crusher building where sand and four sizes of stone are produced in one train of screening, splitting, bypassing and crushing operations. Note dust-control duct system on the building's exterior.

able feature of the drilling is the use of 9-in. holes; tests showed that they gave more economical breakage than smaller holes. Well drills are used and the holes are put down 190 to 200 ft. and 45 ft. apart in a row 24 ft. back from the face. The explosive is nitramon and the holes are loaded to within 20 ft. of the tops. About one blast a month is fired; the average breakage has been about 100,000 tons to a blast and about 3½ tons per pound of explosive. The rock averages about 2.3 tons a yard. Secondary drilling is done with jackhammers.

Primary crushing is done at the quarry plant shown in Fig. 1 by a gyratory crusher set at 4½ in. and fed by 12-yd. trucks loaded by two 3-yd. electric power shovels. Five trucks are used (one spare) and in this hard service 10x37-in. tires (ten per truck) last about 2 years. The crusher has a capacity of about 200 tons per operating hour; like the shovels it is electrically powered. The discharge is to a belt conveyor which passes under a magnet to eliminate tramp iron. Also dust control begins here as described later.

To provide steady supply to the rest of the plant, a 15,000-ton raw-material stockpile (3,000 tons live) is introduced between the primary and the final crushing operations. A rising belt conveyor on a 17 per cent grade takes the primary crusher product 367 ft. to the stockpile; the conveyor rating is 800 tons per hour at 400 ft. per min. travel. The stockpile feeds through an operating and an emergency gate to an under tunnel to a rising belt-conveyor taking the rock 452 ft. to the top of the secondary crusher building 111 ft. high, Fig. 3. The conveyor is rated at 600 tons per hour at 400 ft. per min. Just out of the tunnel a second magnet is located over the belt to remove iron.

In a large sense the heart of the plant is the secondary crusher building. An equipment diagram of this plant is shown by Fig. 4. Here by means of numerous screen separations, splitters, a crusher and four hammermills, ultimate sizes of cobbles (from 6-in. to 3½-in.), coarse rock (from 3½-in. to 1½-in.), medium rock (from 1½-in. to ⅝-in.), fine rock (from ⅝-in to 4-mesh) and below 4-mesh are all delivered to a 30-in. conveyor and then carried to the screening plant. Stockpiles at the screening plant are the barometers by which the splitters are operated to produce the required amounts of different sized aggregates. Fig. 5 is a flowsheet of the operations at the secondary crusher building.

The unique feature is that scalping and bypass screening is applied to five sizes of aggregate, including sand, and the screens are so grouped that a fraction of any one size or group of contiguous sizes may be fed by gravity to three different types of crushers. In general the procedure is: The primary-crusher product besides some +6-in. material contains an excess of cobbles and coarse rock sizes and a deficiency of all sizes below 1½ in. By using splitters the desired amounts of the cobbles and coarse stone are sent direct to conveyor *D*, Fig. 5, to the screening plant, Fig. 6. The remainder of the cobbles and coarse stone and the occasional +6-in. material is fed to the secondary

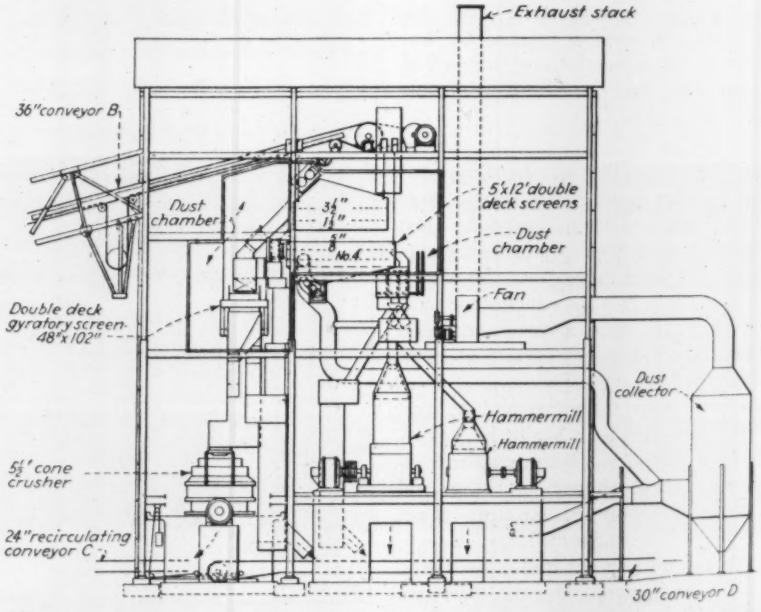


Fig. 4. Diagram of equipment arrangement in crusher building showing hoods inclosing machinery for dust transfer to a duct system leading to dust collector.

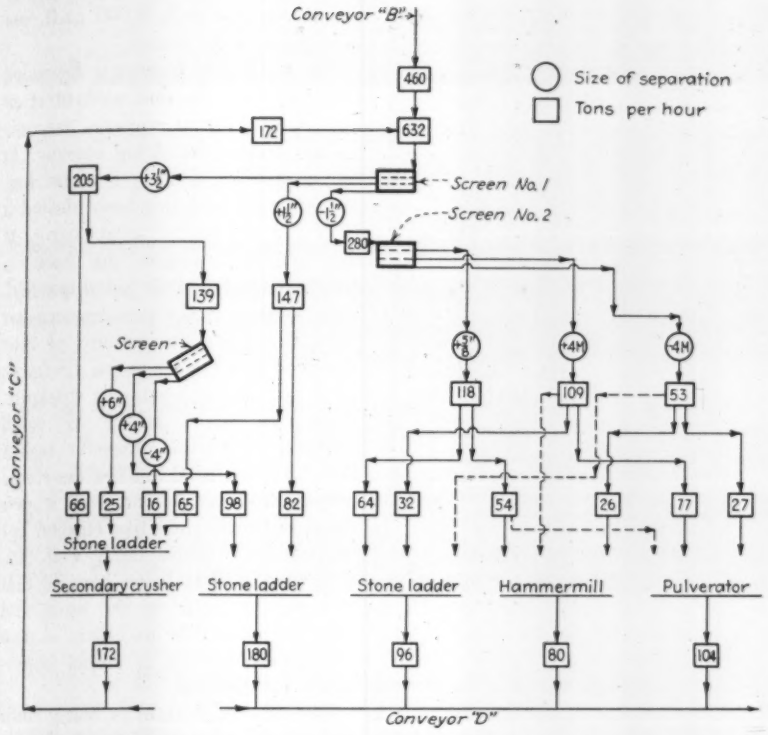


Fig. 5. Flowsheet of rock movement through crusher plant to produce sand and four sizes of stone aggregate in controlled proportions.

crusher. Virtually all of the secondary crusher product is —1½-in. so that on its return by conveyor *C*, Fig. 5, to the screens it finds its way into sizes smaller than 1½ in., with an excess of —1½ to +⅜ in. and of —⅜ to +4-mesh and a deficiency of —4-mesh or sand. The balancing operation is then completed by diverting any desired amount of the medium and fine stone to conveyor *D* and feeding the excess to the hammermills for sand production. Details of the sand grading are more complex but in general it is accomplished by changing the proportion of the feed to the finer and the coarser hammermills. A point to be noted in all the secondary crusher operations is the nearly complete dependence on gravity for material movement.

The combined product of crushing is belt-conveyed to the screening plant, Fig. 6, and to hydraulic classifiers. The screening outfit for four stone sizes, 332 ft. long and 50 ft. above ground, is supported by steel towers at the ends and three steel bents in between, making four bays for a total storage of about 10,000 tons in each bay.

At the end of the stone aggregate screens is the sand-production part of the plant. The successive stone screens include the following: a 4x 14-ft. screen, passing 3½-in. material, two 4x8-ft. screens passing 1½-in. material, two magnetic screens passing ⅜-in. material; two 4x10-ft. screens to which water is added, passing 4-mesh material. The four aggregate sizes required for concrete are the oversize from each of the above screens and are stored below and over a reclaiming tunnel provided with two gates for each stockpile.

A launder takes the 4-mesh material to a Wood auto-vortex bowl classifier, 13 ft. in diameter. Some 1,200 gpm of water is added to the 4-mesh screen. For dewatering, the classifier underflow, which is less than half water, is delivered to a 12-ft. Dorrco washer, thence by conveyor belt to a radial stacker which spreads

Fig. 6. Sizing screens separate the four stone sizes into piles and pass the fine sand to a hydraulic classifier where it is graded and separately piled.

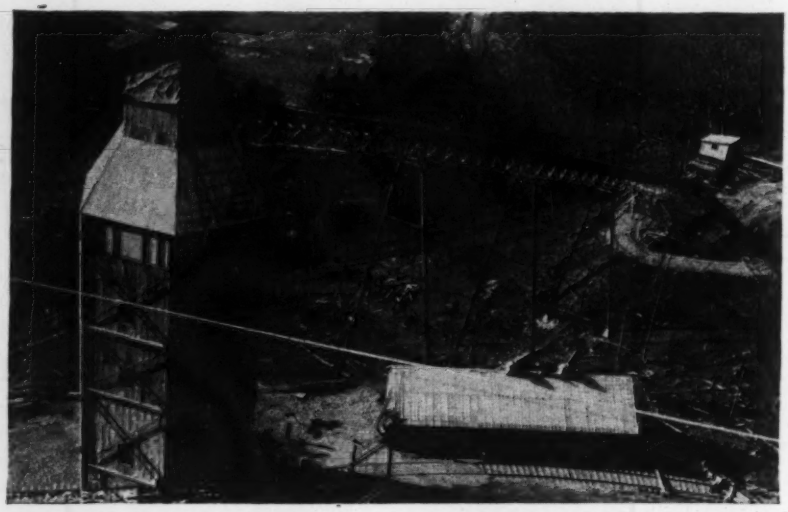


Fig. 7. Into a tunnel under the stone and sand piles the materials are gated in the proper proportions and conveyed by belts to the top of the concrete plant.

it over a 10,000-ton live storage pile. By return of the washer overflow to the bowl classifier instead of wasting it, a saving of 4 per cent of plus 100-mesh material is made.

Eight gates, at 20-ft. intervals, let the sand through the roof of a wooden reclaiming tunnel onto a 24-in. belt conveyor which also receives the proper stone aggregate as it passes under the successive stone storage piles. This reclaiming belt discharges onto rinsing screens the product from which goes to a turnhead at the top of the concrete mixing plant 380 ft. over a belt conveyor. A bulldozer is used to reclaim the wet sand from the large sand storage pile.

Rinsing is carried out by passage over two 9x14-ft. low-head perforated plate screens with $\frac{3}{16}$-in. x 1-in. staggered slots. The first 4 ft. of the screen is sprayed. Dewatering over the next 10 ft. of screen is facilitated by compressed air jets located at the end of the screen. The sand bypasses the rinsing screens.

Dust carefully controlled

The high percentage of silica in the rock made dust control in crushing and conveying a desirable health measure. It begins at the quarry crusher and continues to the screens. Three methods are employed: (1) hood and duct systems in connection with dust separators, where the dust concentrations are normally the highest; (2) exhaust fans, without dust separators, where fans can be used effectively and where the amount of dust in fan discharge is small enough to be safely discharged into the atmosphere at some distance from operations; and (3) wetting the material to reduce dust concentrations at places where the first two methods are not practicable because of the scattered nature of operations, or where high efficiency in dust removal is not essential.

The first method is used at the primary crusher and at the crusher building. The discharge from the primary crusher onto a 42-in. belt is completely enclosed, and the dust produced in the crushing operation is removed by two ducts leading to a wet dust collector. A centrifugal fan pulls about 3,500 cu.ft. per min. through the system and discharges through a stack. At the crusher building a system of ducts (Fig. 4) serves: (1) the discharge from the secondary crusher, (2) a room completely enclosing the screens, (3) the four feeding points on conveyor *D*, and (4) the hammermill feed-distributing box. The duct system leads to a wet dust collector outside the building. A centrifugal fan inside the building pulls 25,000 cu.ft. per min. through the system and exhausts through a stack outside the building.

The second method is used at the two reclaiming tunnels. In the 85-ft. tunnel under the primary-product storage a centrifugal fan at the dead end of the tunnel pulls 6,000 cu.ft. per min. through the entire length of the tunnel and exhausts through a 20-in. duct into the atmosphere. In the long reclaiming tunnel under the finished-aggregate storage a propeller fan at one end pulls 6,000 cu.ft. per min. through the tunnel.

The method of wetting is depended upon to reduce the dust concentration at the quarry, at various transfer points, and at the sizing screens. At the quarry all drilling is done wet, and after the rock has been blasted it is thoroughly soaked by spraying. At the primary crusher the rock is sprayed again as it is being crushed. This wetting at the primary crusher helps to reduce the amount of dust liberated into the air at the discharge of *A* belt into the primary stockpile. Water is again added in small amounts at various transfer points before the material reaches the sizing screens, so that by the time it gets there sufficient time has elasped for the water to diffuse fairly well. Another factor that helps here is that screening is done in the open and even if appreciable quantities of dust are liberated there is ample opportunity for dilution.

The Hiwassee Dam is being built under the Tennessee Valley Authority by force account under the general direction of T. B. Parker, chief engineer and A. L. Pauls, chief construction engineer. C. E. Blee is project engineer, O. Laurgaard is construction engineer and J. E. Walters is construction superintendent.

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More Trade Expected From Latin America

The Pan American Trade Committee of San Francisco has established a Housing, Building and Construction Department to promote and expand Latin American markets for U. S. building and construction materials.

The new department will concentrate its efforts on encouraging large-scale housing projects, a policy in line with present endeavors of Latin American governments.

Initial action of the department, already under way, is a comprehensive study of the construction problems, housing and other public projects, of the nineteen Spanish Americas, leading to the appointment of trade delegates in each country who will actively engage in the promotion of U. S. products.

Further details about the plan may be had by communicating with the Pan American Trade Committee, Kohl Building, Montgomery and California Sts., San Francisco.

Concrete Corners in Tension

D. B. GUMENSKY
Engineer
The Metropolitan Water District of Southern California

Contents in Brief — Tests reveal importance of proper anchorage for reinforcing subjected to tension and bending stresses in the corners of rectangular conduits.

IN LOW-HEAD INVERTED SIPHONS made of concrete, a square or a rectangular shape often has advantages over the conventional circular section. Such was the case with siphons in the Colorado River Aqueduct, where sections made up of three square barrels were used. (*ENR*, June 27, 1935, p. 899). Because the corners of such a section, when subjected to internal hydrostatic pressure, tend to crack and open up on the inside, the method of anchoring reinforcing bars in the corner has a direct bearing on the strength of the barrel. When the superiority of the type of corner reinforcement selected for the Colorado River Aqueduct was questioned, a series of tests was undertaken.

Five types of reinforcement, shown in the drawing, were compared. Type A, with a 6-in. fillet and a proportionally larger corner bar, was used for all square-barrel siphons. Type B was used in transitions and secondary structures such as wells where inner corner reinforcement was not a determining factor. Type C was suggested in an endeavor to facilitate the placement of steel, as it would allow the use of shorter bars. Types D and E, with hooks turned outward, were proposed to relieve congestion of steel in the corner and to facilitate the placing of concrete. Dimensions of the test specimens were made such as to give the same relation between direct tension and bending moment as would exist in a 10-ft. square conduit under hydrostatic load. The moment at the corner was computed to equal $M_c = 12.73\ T$ in.-lb. where T is tension on the pull bar in pounds.

Three specimens of each type were prepared, fifteen in all. Forms were built and reinforcing steel was bent and tied in the forms within a tolerance of $\frac{1}{16}$ in. All specimens were made from one batch of concrete, and after stripping were stored in a moist room at 70 deg. F. until tested. Tests were made when the concrete was 28 days old, and had an average strength of 4,117 lb. per sq. in.

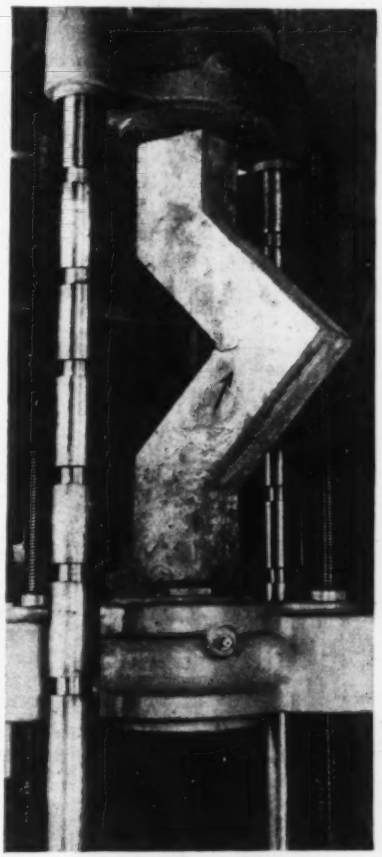


Fig. 1. Corner specimen under tension; arrow indicates first crack location typical for all specimens.

In the testing machine tension was applied at the rate of about 4,000 lb. per min. The pull was read twice: first when the first crack appeared on the inside of the specimen elbow and again at failure, as indicated in the table. The notable feature of the test was that the first crack appeared in all specimens at about the same tension. This is ascribed to the failure of bond between steel and concrete as bond stress was about the same for all specimens. The ultimate strength of the specimen is thought to have been determined by the mechanical bond or, rather, by the total strength of steel-to-concrete anchorage.

TABLE I—RESULTS OF TENSION TESTS ON FIFTEEN SPECIMENS

Type	Description of Reinforcement	Pull at First Crack lb.*	Maximum Pull at Failure lb.*
(a)	5-in. loop and ½-in. round corner bar..	6,733	22,336
(b)	5-in. loop	6,733	10,266
(c)	5-in. hook	6,133	8,666
(d)	3-in hook	6,100	7,533
(e)	5-in. hook	6,150	6,533

* In each case the figures are the averages of three tests.

The tests bring out the advantages of a complete loop in the reinforcing bar in the corner and the addition of a crossbar with enclosing fillet. The loop develops the ultimate strength of the bar by winding it around the core of concrete contained within the loop; the crossbar increases the strength of the corner somewhat in proportion to the amount of the added metal. All tests were made under the direction of L. H. Tuthill, testing engineer for the Metropolitan Water District.

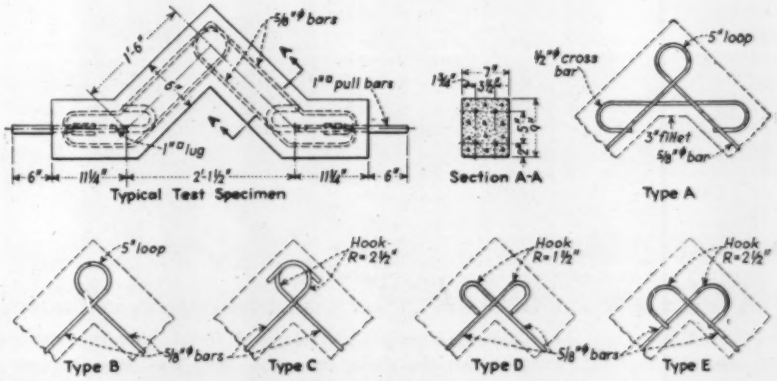


Fig. 2. Test specimen dimensions and five types of corner reinforcement.

Sanitary Fill Disposal Method Preferred at Portland

Contents in Brief—After long experience in disposing of garbage and refuse by incineration, as well as in sanitary fills, Portland, Ore., finds the fills more satisfactory at far less than incineration costs.

GARBAGE AND REFUSE collected in Portland, Ore., for many years has been disposed of by incineration and in sanitary fills. In general, incineration has been costly and sites suitable for large sanitary fills were found only in outlying districts entailing long hauls. In the light of recent developments, however, it is expected that all city-managed disposal, using both methods, soon will be concentrated on the St. Johns disposal site. At this point, the city built a 150-ton per day incinerator in 1932 and lately has acquired enough adjacent land to permit of sanitary fill disposal there for at least 20 years.

Because incinerator and fill are here operated in conjunction, direct cost comparisons between the two methods can be made. For 1938 these relative costs were 81½ and 39¼ cents per ton respectively. This incinerator cost is an operating net, exclusive of interest or depreciation, but including all salaries, maintenance, supplies and repairs. An important element in incinerator cost is labor; at the incinerator more labor is required and a higher rate is paid than on the fill.

Incinerator experience

Portland's experience with incinerators dates back to 1897, when the first one was built near Guilds Lake in the north part of the city. This was replaced in 1910 by the incinerator that now occupies the same location. Although its furnaces were reconstructed in 1927, at present they are in such condition that the plant is to be abandoned soon. Anticipation of this abandonment led to building a $131,000, three-unit incinerator near St. Johns, about 10 mi. from downtown Portland.

Since building this second incinerator, methods of making sanitary fills have improved so materially that city officials now regard fill disposal as an entirely satisfactory and a much more economical method. However, the incinerator is being used enough to keep its equipment in operating condition even while filling is going on nearby. Incinerator and fill work well together because clinkers, ashes, tin cans, etc., taken from the ash pit are excellent materials for making roads on the fill.

Typical dumping scene on the face of the St. Johns fill. Initially 8 or 10 ft. deep, this will be compacted to 6 or 7 ft. before earth cover is applied.

This bulldozer has just tilted downward on the slope of freshly dumped garbage at the St. Johns fill. The fact that the tractor has sunk some 2 ft. into the loose material illustrates the compaction that takes place.

Portland has used sanitary fills since about 1923 and has made them in various parts of the city including residential areas. Many fills had considerable depths, some 40 ft. or more. In Overlook Park, a fill 45 to 85 ft. deep was begun in 1930. Because of the high-class neighborhood, also because considerable settlement was expected, loose dirt was used for about one-third the total fill volume. Even so, there was constant danger, when the fill was fresh, of sloughing on the deep face with attendant odor nuisance. Also, as was expected, the ultimate settlement amounted to about 25 per cent of the depth for 10 years.

Some of the deep fills settled gradually, others, after settling slowly for as long as seven years after completion would then suddenly settle sev-

eral feet. Temperature investigations indicated that considerable heat develops in these deep fills at the outset and does not disappear entirely for 10 years or more.

Compacted fills are better

In recent years filling methods have been greatly improved particularly by the use of tractors for shoving the material over the face of the dump and compacting it. This compaction has greatly increased the quality of the fills and has eliminated some serious objections.

After using tractors for compaction, a fill 7 to 8 ft. deep can be covered with a 1-ft. layer of earth and there will thereafter be no danger of sloughing. The vibration caused by the tractors frightens rodents into hiding and even though they are brought to the fill frequently in loads of garbage, inspectors find that they have been buried and destroyed and report that there are no rats in compacted fills.

On the St. Johns fill where garbage deliveries now amount to about 75 tons per day, only two men are employed; one operates the tractor (bulldozer) at the dumping point and the other brings up loose earth with a caterpillar-drawn fresno. Ordinarily the fresno is used to excavate soft ground ahead of the fill and after a layer of filling has been completed, delivers earth to a point where the bulldozer can make the necessary cover. Cover material is here moved ½ mi. as a maximum. On this fill the city contemplates an ultimate depth of three layers—about 20 ft. The total area now owned by the city (including the incinerator grounds) is about 290 acres.

On this fill the final cover will be a 3-ft. layer of topsoil. This depth is adequate for plant growth but in raising crops on fills so made, the heat generated for several years (noticeable in some cover material for 4 yr. or more) would have to be reckoned with. This heat is an advantage in forcing growth in winter and spring, but it is a detriment in the dry summer period because it unduly dries out the subsoil.

Daily routine

The working day on the St. Johns fill is eight hours. The first trucks arrive at about 10 a.m. and the last about 5 p.m. Freshly dumped garbage is not always covered the same day, but the rule is that each day's filling must be compacted and rolled tight with the tractor before the day's work is completed.

Salvage of junk is permitted on this fill and the operation of individual "pickers" is regarded as an advantage in compaction. The pickers are required to have permits which are issued without limitation; the permit maintains control in case it becomes necessary to discipline the pickers.

Portland scavengers haul the garbage and maintain their own trucks without cost to the city. Minimum charge collected by scavengers from householders is 50c. per month. Sometimes privately operated fills nearer than St. Johns are available for disposal. When this obtains, tonnage delivered to St. Johns is correspondingly less. However, the city maintains the St. Johns fill and permits free use of it to the scavengers who wish to deliver there.

Garbage—rubbish ratio

Portland scavengers now collect an average of 250 to 300 tons per day in which the range is 80 to 90 per cent garbage, and 10 to 20 per cent rubbish. The average bulk of this material is 4 cu. yd. or more per ton. In addition, food waste from restaurants and hotels is collected by hog raisers. Eleven licensed collectors, using covered trucks, gather perhaps 15 tons of food waste per day, subject to state, county and city regulation.

Portland's bureau of garbage disposal is operated under the direction of William G. Helber, superintendent, who has been in charge of Portland's garbage disposal since 1913.

Waste Disposal Profitable At Fresno, Calif.

WASTE DISPOSAL is profitable in the city of Fresno, Calif., (population 65,000) even though the principal revenue is only the monthly charge which citizens pay for garbage collection and the rates are low—45c. per month for the small householder's weekly collection. The city took over the garbage collection service from private operators some four years ago, greatly improved the methods (*ENR*, Apr. 25, 1935, p. 592) and as experience with collection and disposal methods increased, still further reduced costs (*ENR*, March 10, 1938, p. 365). In 1937, $8,000 was transferred from the surplus account of the waste disposal department to the city's general fund for the reduction of taxes and last year another $20,000 was used for the same purpose.

Operating surplus

This does not mean an earning of $20,000 in the one year; rather it is the city's current draft on the surplus of some $61,000 remaining as earnings in the waste disposal department over a period of several years and after previous deductions. For the fiscal year ending June 30, 1938, the net operating surplus was $13,986; for the preceding 12 months' period, $12,862. These profits are those which accrue after writing off all charges including reserves for depreciation of plant and equipment.

The reserve account includes allowances for depreciation of field equipment, tools, buildings, office furniture and motor trucks. Three trucks purchased in 1934 recently were replaced under the provisions of the equipment maintenance account. Since the waste disposal department was started the city purchased the site for a new corporation yard at a cost of $5,500, which was paid for by the waste disposal department, as was the cost of buildings including rest and recreation rooms at the yard for the use of city employees.

Jean L. Vincenz, Fresno commissioner of public works, under whom the waste disposal department operates, reports it to be "a very great asset to the city from a financial standpoint as well as a great aid in keeping the city clean". Ralph P. Tocchini is superintendent of the department.

Inventory of Water Supply Facilities

TWO-THIRDS of the total population in the United States is served by community water systems, according to a nation-wide survey just completed by *Engineering News-Record*. There are 12,750 waterworks for the 13,293 communities enjoying central supply and distribution facilities. Most of the systems are publicly owned, with only about 27 per cent operated by private utility companies; on a population-served basis, private water utilities deal with only 11 per cent of the business.

The survey, which was compiled from official data furnished by state sanitary engineers, includes for each of the 48 states and the District of Columbia, information on the number of people and communities served by water systems, ownership of systems, sources of supply, and a detailed tabulation of treatment facilities. This inventory supplements a similar study of sewage disposal facilities in the United States made by *Engineering News-Record* and published in the issue of Jan. 19, 1939. Reprints of this and of the waterworks inventory are available by request to the editorial department.

It is interesting to note that 85 per cent of the 81,200,000 people served by public and private systems, receive water that has been given treatment for health protection, quality improvement or both. However, chlorination is practiced at only 4,015 plants of the 12,750 waterworks systems which are now in operation. Filtration facilities are found in 2,188 plants, of which only 97 are of the slow sand type.

The emphasis that is being placed on higher standards of water quality is revealed in the data on the number of plants employing treatment measures in addition to filtration and disinfection. Here it is shown that 1,187 plants have adopted taste and odor control, 417 use iron and manganese removal processes, and 484 soften their supply.

Systems depending on groundwater as a source of supply outnumber those using surface supplies by almost three to one. About 9,100 systems employ groundwater as compared to some 3,300 which draw from streams and lake sources.

With regard to the number of people served by water systems, the inventory shows that New York state leads with a total of 11,599,000. Arranged in the order of population served, the first nine states are:

New York	11,599,000
Pennsylvania	8,144,000
Illinois	6,067,000
New Jersey	4,398,000
California	4,230,000
Massachusetts	4,153,000
Michigan	3,645,000
Texas	2,929,000
Indiana	2,014,000

It is difficult to make a comparison of the present status of water supply facilities with that of other years because few data have heretofore been available. Perhaps the nearest approach to a comparative statement is to be found in a survey conducted by *Engineering News-Record* in 1928, part of which is based on estimates. At that time the total number of waterworks systems was reported as 10,679. The ratio of public to private ownership, based on incomplete returns, was roughly 4 to 1, about the same as it is today.

The state sanitary engineers who so ably assisted in making this inventory are listed below:

STATE SANITARY OFFICIALS WHO SUPPLIED DATA

G. H. Hazlehurst	Chief Engineer	Alabama
F. C. Roberts, Jr.	Sanitary Engineer	Arizona
F. L. McDonald	Chief Engineer	Arkansas
C. G. Gillespie	Chief, Bur. of San. Eng.	California
Benjamin V. Howe	Sanitary Engineer	Colorado
Warren J. Scott	Director of San. Eng.	Connecticut
Richard C. Beckett	Sanitary Engineer	Delaware
G. F. Catlett	Chief Engineer	Florida
W. H. Weir	Assistant Director	Georgia
W. V. Leonard	Sanitary Engineer	Idaho
C. W. Klassen	Chief Sanitary Engineer	Illinois
B. A. Poole	Chief Engineer	Indiana
A. H. Wieters	Director	Iowa
Earnest Boyce	Chief Engineer	Kansas
F. C. Dugan	Director	Kentucky
John H. O'Neill	Sanitary Engineer	Louisiana
E. W. Campbell	Director	Maine
George L. Hall	Chief Engineer	Maryland
A. D. Weston	Chief Engineer	Massachusetts
Edward D. Rich	Director	Michigan
H. A. Whittaker	Director	Minnesota
H. A. Koreze	Director	Mississippi
W. Scott Johnson	Chief Pub. Health Engineer	Missouri
H. B. Foote	Director	Montana
T. A. Filipi	Public Health Engineer	Nebraska
W. W. White	Sanitary Engineer	Nevada
Charles D. Howard	Director	N. Hampshire
H. P. Croft	Chief Engineer	New Jersey
Paul S. Fox	Chief	New Mexico
C. A. Holmquist	Director	New York
W. H. Booker	Director	N. Carolina
L. K. Clark	Acting Director	N. Dakota
F. H. Waring	Chief Engineer	Ohio
E. C. Warkinten	Ass't. San. Engineer	Oklahoma
Carl E. Green	Sanitary Engineer	Oregon
H. E. Moses	Chief Engineer	Pennsylvania
Eskil C. Johnson	Engineer	Rhode Island
B. P. Rice	Sanitary Engineer	S. Carolina
W. W. Towne	Director	S. Dakota
W. C. Williams	Commissioner	Tennessee
V. M. Ehlers	Director	Texas
L. M. Thatcher	Director	Utah
E. L. Tracy	Sanitary Engineer	Vermont
Richard Messer	Director	Virginia
Roy M. Harris	Chief	Washington
J. B. Harrington	Director	W. Virginia
L. F. Warrick	Sanitary Engineer	Wisconsin
L. O. Williams, Jr.	Sanitary Engineer	Wyoming

C. E. Shingler, Capt., U. S. Engineer Corps., District of Columbia

Inventory of Water Supply Facilities in the Unit

Compiled by Engineering News-Record from Data Supplied by State Sanitary E

State and Region	Population					Ownership						Source of Water (Number of Supply Systems)					Treatmen (Number of				
						Communities Served by Waterworks			Number of Waterworks			Ground			Surface		Filtration			Dis-infection	
	Total Population 1930 Census	Served by Publicly Owned Systems	Served by Privately-Owned Systems	Total Population served by both Public & Private Systems	Served with Treated Water	Publicly Owned	Privately Owned	Both Public & Private	Publicly Owned	Privately Owned	Both Public & Private	Driven & Bored	Springs & Shallow Dug Wells	Infiltration Galleries	Streams	Lakes	Slow sand	Rapid or Mech. Gravity	Rapid or Mech. Pressure	Chlorine	Other means
New England																					
Maine	797,423	347,639	164,093	511,732	475,235	76	123	199	45	121	166	16	49	0	39	62	3	11	4	96	0
New Hampshire	465,293	290,700	74,300	365,000	54,900	85	46	131	77	46	123	16	29	0	54	24	6	6	0	31	0
Vermont	359,611	165,000	22,000	187,000	75,230	81	34	115	85	44	129	2	78	....	38	18	1	2	....	5	....
Massachusetts	4,249,614	3,890,076[4]	151,056[4]	4,153,049	3,217,417	201[4]	38[4]	254	232	74	306	78[4]	37[4]	2[4]	46[4]	37[4]	12	10	0	79	0
Rhode Island	687,497	606,010	62,167	668,177	636,920	28	58	86	11	47	58	28	16	....	7	7	0	5	2	20	0
Connecticut	1,606,903	735,700	747,800	1,483,500	1,444,100	61	140	201	21	85	106	16	14	....	4	102	6	14	4	100	....
TOTAL	**8,166,341**	**6,035,125[4]**	**1,221,416[4]**	**7,368,458**	**5,903,802**	**532**	**439**	**986**	**471**	**417**	**888**	**156**	**223**	**2**	**188**	**250**	**28**	**48**	**10**	**331**	**0**
												<—32—>			<—45—>						
												<—29—>									
Middle Atlantic																					
New York	12,588,066	10,148,892	1,450,346	11,599,238	11,385,560	668	499	1,167	475	297	772	209[4]	155[4]	5[4]	233[4]	87[4]	29	75	37	380	0
New Jersey	4,041,334	3,105,584	1,292,568	4,398,152	3,295,229	243	337	580	188	198	386	283	24	4	53	4	5	26	32	172	0
Pennsylvania	9,631,350	4,267,938	3,875,882[3]	8,143,820[3]	8,000,000[3]	.....	.....	.....	229	432	661[4]	102	74[4]	5	313[4]	15	16	195	9	440	0
Maryland	1,631,526	1,157,656[6]	48,000[6]	1,205,656[6]	1,143,703	74[7]	62	136	61	62	123	66	32	1[5]	33	0	0	19[6]	1	48	0
Delaware	238,380	146,127	13,755	159,882	115,000	24	7	31	23	6	29	27	....	....	....	....	0	2	....	2	....
District of Columbia	486,869	512,938	.....	512,938	512,938	3	0	3	1	0	1	....	....	....	1	....	1	1	....	2	2
TOTAL	**28,617,525**	**19,339,135**	**6,680,551**	**26,019,686**	**24,452,430**	**1,012**	**905**	**1,917**	**977**	**995**	**1,972**	**687**	**285**	**15**	**633**	**106**	**51**	**318**	**79**	**1,044**	**2**
												<—33—>			<—3—>						
												<—114—>									
Southern																					
Virginia	2,421,851	929,030	142,158	1,071,188	780,434	201	204	405	176	196	372	148	123	2	93	6	1	71	7	98	0
West Virginia	1,729,205	308,456	433,171	741,627	676,490	92	234	326	84	212	296	141	31	17[2]	107	0	0	79	28	171	0
North Carolina	3,170,276	963,264	55,014	1,018,278	750,000[3]	255	31	286	255	31	286	116	20	1	107	0	1	101	5	131	0
South Carolina	1,738,765	461,000	48,000	509,000	409,000	117	16	133	117	16	133	85	5	....	42	1	0	41	4	51	1
Georgia	2,908,506	1,191,217	23,283	1,214,500	1,056,500	336	9	345	336	9	345	219	46	0	<—80—>		0	85	0	167	0
Florida	1,468,211	795,670	145,148	940,818	814,897	159	69	228	159	69	228	227	....	0	11	16	0	33	2	54	0
Alabama	2,646,248	466,756[2]	600,750[3]	1,067,506[3]	961,260[3]	137	137	274	124	113	237	129[4]	58[4]	0	60[4]	....	1	58	1	68	2
Mississippi	2,009,821	476,689	22,257	498,946	151,056	191	14	205	191	14	205	196	5	0	3	1	0	6	7	20	0
Louisiana	2,101,593	837,850	132,000	969,850	735,000	113	61	174	113	61	174	143	8	0	20	3	0	31	4	42	0
Kentucky	2,614,589	728,777	239,670	968,447	939,014	120	91	211	97	89	186	66	14	6[2]	68	32	0	88	5	147	0
Tennessee	2,616,556	841,021	201,931	1,042,952	963,979	141	66	207	133	62	195	99	88	0	33	4	0	34	5	114	1
TOTAL	**25,425,621**	**7,999,730**	**2,043,382**	**10,043,112**	**8,237,630**	**1,862**	**932**	**2,794**	**1,785**	**872**	**2,657**	**1,569**	**398**	**26**	**544**	**63**	**3**	**627**	**68**	**1,063**	**4**
															<—80—>						
												<—10—>									
Middle West																					
Ohio	6,646,697	4,630,420	222,093	4,852,513	4,368,468	455	38	493	378	32	410	300	19	0	76	15	0	48	0	32	0
Indiana	3,238,503	1,174,354	839,518	2,013,872	1,810,204	250	59	309	250	58	308	238	21	3	34[10]	8	1	40	6	152	0
Illinois	7,630,654	5,483,163	583,635	6,066,798	5,417,325	570	62	632	504	42	546	431	10	1	41	63	0	98	36	166	0
Wisconsin	2,939,006	1,706,808	87,611	1,794,419	1,328,160	341	21	362	320	21	341	271	41	2	9	18	1	14	4	31	0
Michigan	4,842,325	3,593,317	51,189	3,644,506	3,087,325	363	38	401	324	38	362	<—279[4]—>			<—80[4]—>		1	37	1	51	0
TOTAL	**25,297,185**	**16,588,062**	**1,784,046**	**18,372,108**	**16,011,482**	**1,979**	**218**	**2,197**	**1,776**	**191**	**1,967**	**1,240**	**91**	**6**	**160**	**104**	**3**	**237**	**47**	**432**	**0**
												<—279—>			<—80—>						
												<—3—>									
W. of Mississippi																					
Minnesota	2,563,953	1,488,574	25,590	1,514,164	1,058,278	439	12	451	431	10	441	371	42	2	12	13	0	26	8	35	2
Iowa	2,470,939	1,183,364	165,030	1,348,394	1,000,973	548[3]	13	561	548	13	561	424[9]	91	6	36[10]	4	0	58	45	110	....
Missouri	3,629,367	1,259,538[3]	451,302[3]	1,710,840[3]	1,357,685[3]	211	75	286	204	47	251	149	32	6	33	33	0	79	10	98	1
Arkansas	1,854,482	293,984	222,075	516,059	371,454	115	59	174	114	59	173	131	13	0	20	14	0	39	5	50	0
North Dakota	680,845	183,643	5,876	189,519	71,000	97	3	100	97	3	100	79	12	2	6	1	0	11	1	10	0
South Dakota	692,849	248,503	13,701	262,204	148,558	187	3	190	187	3	190	120	62	0	4	4	0	14	3	31	0
Nebraska	1,377,963	758,358	16,735	775,093	395,725	397	3	400	396	3	399	380	8	5	11	0	0	16	3	20	0
Kansas	1,880,999	820,502	177,315	997,817	741,026	360	20	380	355	20	375	<—315—>			41	19	0	67	4	89	0
Oklahoma	2,396,040	1,086,822	41,721	1,128,543	727,576	308	23	331	308	23	331	232	3	1	35	55	0	68	4	97	0
Texas	5,824,715	2,570,201	358,996	2,929,197	2,005,061	474	125	599	474	125	599	458	20	3	40	78	0	66	9	183	3
Montana	537,606	174,154	75,045	249,199	171,322	95	21	116	95	21	116	27	38	5	44	3	1	10	0	41	0
Wyoming	225,565	20,735	111,193	131,928	85,309	57	12	69	57	9	66	27	7	12	18	5	2	3	14	16	....
Colorado	1,035,791	603,902	11,552	615,454	496,587	184	20	204	174	20	194	47	53	27	94	2	3	12	3	32	0
New Mexico	423,317	102,282	67,864	170,146	75,216	37	26	63	37	23	60	37	5	5	13	0	0	2	2	14	....
TOTAL	**25,594,431**	**10,794,562**	**1,743,995**	**12,538,557**	**8,705,770**	**3,509**	**415**	**3,924**	**3,477**	**379**	**3,856**	**2,482**	**386**	**74**	**407**	**231**	**6**	**471**	**111**	**826**	**6**
												<—315—>									
Far West																					
Idaho	445,032	187,567	31,778	219,345	104,484	89	14	103	84	14	98	63	24	3	11	4	1	1	3	1	23
Utah	507,847	383,988	33,058	417,046	246,700	147	86	233	147	86	233	16	191	3	23	....	....	1	2	27	....
Arizona	435,573	126,367	96,244	222,611	137,825	23	46	69	21	45	66	42	18	4	7	....	2	1	2	27	....
Nevada	91,058	21,500	49,000	70,500	38,200	16	27	43	19	24	43	18	31	2	5	7	1	1	3	8	4
Washington	1,563,396	954,618	119,439	1,074,057	885,873	196	142	338	170	140	310[11]	86	83	1	97	13	0	8	2	77	0
Oregon	953,786	608,000	60,000	668,000	559,000	220	166	386	220	166	386	89	114	5	185	4	0	7	8	90	0
California	5,677,251	3,780,000	450,000	4,230,000	3,410,000	206	97	303	189	95	284	25	19	6	66	15	2	19	17	89	0
TOTAL	**9,673,943**	**6,062,040**	**839,519**	**6,901,559**	**5,382,082**	**897**	**578**	**1,475**	**850**	**570**	**1,420**	**339**	**480**	**24**	**394**	**43**	**6**	**38**	**37**	**319**	**27**
GRAND TOTAL	**122,775,046**	**66,818,654[4]**	**14,312,909[4]**	**81,243,480**	**68,693,196**	**9,791**	**3,487**	**13,293**	**9,336**	**3,424**	**12,760**	**6,473**	**1,863**	**147**	**2,326**	**797**	**97**	**1,739**	**352**	**4,015**	**39**
												<—659—>			<—208—>						
												<—156—>									

Water Supply Facilities in the United States–1939

Compiled by Engineering News-Record from Data Supplied by State Sanitary Engineers

Ownership: Communities Served by Waterworks: Publicly Owned	Ownership: Communities Served by Waterworks: Privately Owned	Ownership: Communities Served by Waterworks: Both Public & Private	Ownership: Number of Waterworks: Publicly Owned	Ownership: Number of Waterworks: Privately Owned	Ownership: Number of Waterworks: Both Public & Private	Source of Water (Number of Supply Systems): Ground: Driven & Bored	Ground: Springs & Shallow Dug Wells	Ground: Infiltration Galleries	Surface: Streams	Surface: Lakes	Treatment Facilities (Number of Plants Using): Filtration: Slow sand	Filtration: Rapid or Mech. Gravity	Filtration: Rapid or Mech. Pressure	Dis-infection: Chlorine	Dis-infection: Other means	Softening: Lime-Soda Ash	Softening: Zeolite	Auxiliary Treatment: Iron Removal	Auxiliary Treatment: Manganese Removal	Taste & Odor Control: Ammonia	Taste & Odor Control: Activated Carbon	State and Region
76	123	199	45	121	166	16	49	0	39	62	3	11	4	96	0	0	0	2	0	10	4	New England
85	46	131	77	46	123	16	29	0	54	24	6	6	0	31	0	5	0	3	0	0	4	Maine
81	34	115	85	44	129	2	78	....	38	18	1	2	....	5	....	....	....	....	....	1	1	New Hampshire
201[4]	38[4]	254	232	74	306	78[1]	37[1]	2[1]	46[1]	37[1]	12	10	0	79	0	0	0	10	0	6	2	Vermont
28	58	86	11	47	58	28	16	....	7	7	0	5	2	20	0	0	0	0	0	2	3	Massachusetts
61	140	201	21	85	106	16	14	....	4	102	6	14	4	100	....	....	....	....	....	10	7	Rhode Island
532	**439**	**986**	**471**	**417**	**888**	**156**	**223**	**2**	**188**	**250**	**28**	**48**	**10**	**331**	**0**	**5**	**0**	**15**	**0**	**29**	**21**	Connecticut
						<—32—>			<—45—>													**TOTAL**
						<—29—>																
668	499	1,167	475	297	772	209[1]	155[1]	5[1]	233[1]	87[1]	29	75	37	380	0	0	8	6	0	78	63	**Middle Atlantic**
243	337	580	188	198	386	283	24	4	53	4	5	26	32	172	0	0	1	26	0	30	14	New York
.....	.....	.....	229	432	661[5]	102	74[1]	5	313[1]	15	16	195	9	440	0	28	10	9	3	45	35	New Jersey
74[7]	62	136	61	62	123	66	32	1[2]	33	0	0	19[6]	1	48	0	0	3	8	0	5	7	Pennsylvania
24	7	31	23	6	29	27	....	....	....	....	0	2	....	2	....	....	....	3	....	....	....	Maryland
3	0	3	1	0	1	....	....	....	1	....	1	1	....	2	2	....	....	....	....	2	1	Delaware
1,012	**905**	**1,917**	**977**	**995**	**1,972**	**687**	**285**	**15**	**633**	**106**	**51**	**318**	**79**	**1,044**	**2**	**28**	**22**	**52**	**3**	**160**	**120**	District of Columbia
						<—33—>			<—3—>													**TOTAL**
						<—114—>																
201	204	405	176	196	372	148	123	2	93	6	1	71	7	98	0	2	2	4	0	8	18	**Southern**
92	234	326	84	212	296	141	31	17[2]	107	0	0	79	28	171	0	6	7	27	0	10	25	Virginia
255	31	286	255	31	286	116	20	1	107	0	1	101	5	131	0	2	1	10	0	18	16	West Virginia
117	16	133	117	16	133	85	5	....	42	1	0	41	4	51	1	1	2	2	0	15	40	North Carolina
336	9	345	336	9	345	219	46	0	<—80—>		0	85	0	167	0	2	2	3	0	6–8	25–30	South Carolina
159	69	228	159	69	228	227	....	0	11	16	0	33	2	54	0	28	4	8	0	15	0	Georgia
137	137	274	124	113	237	129[1]	58[1]	0	60[1]	....	1	58	1	68	2	0	3	9	3	0	6	Florida
191	14	205	191	14	205	196	5	0	3	1	0	6	7	20	0	0	0	8	0	1	2	Alabama
113	61	174	113	61	174	143	8	0	20	3	0	31	4	42	0	22	4	4	0	3	3	Mississippi
120	91	211	97	89	186	66	14	6[2]	68	32	0	88	5	147	0	13	1	8	0	11	21	Louisiana
141	66	207	133	62	195	99	88	0	33	4	0	34	5	114	1	2	0	13	0	10	10	Kentucky
1,862	**932**	**2,794**	**1,785**	**872**	**2,657**	**1,569**	**398**	**26**	**544**	**63**	**3**	**627**	**68**	**1,063**	**4**	**78**	**26**	**96**	**3**	**98**	**169**	Tennessee
									<—80—>													**TOTAL**
						<—10—>																
455	38	493	378	32	410	300	19	0	76	15	0	48	0	32	0	89	20	22	0	0	0	**Middle West**
250	59	309	250	58	308	238	21	3	34[10]	8	1	40	6	152	0	3	3	11	1	17	17	Ohio
570	62	632	504	42	546	431	10	1	41	63	0	98	36	166	0	28[9]	20[9]	14	9	27	85	Indiana
341	21	362	320	21	341	271	41	2	9	18	1	14	4	31	0	8	3	5	2	11	11	Illinois
363	38	401	324	38	362	<—279[1]—>			<—80[1]—>		1	37	1	51	0	9	2	2	0	21	16	Wisconsin
1,979	**218**	**2,197**	**1,776**	**191**	**1,967**	**1,240**	**91**	**6**	**160**	**104**	**3**	**237**	**47**	**432**	**0**	**137**	**48**	**54**	**3**	**76**	**129**	Michigan
						<—279—>			<—80—>													**TOTAL**
						<—3—>																
439	12	451	431	10	441	371	42	2	12	13	0	26	8	35	2	9	2	17	3	16	6	**W. of Mississippi**
548[8]	13	561	548	13	561	424[3]	91	6	36[10]	4	0	58	45	110	....	22	6	61	0	12	33	Minnesota
211	75	286	204	47	251	149	32	6	33	33	0	79	10	98	1	5	6	8	0	8	59	Iowa
115	59	174	114	59	173	131	13	0	20	14	0	39	5	50	0	4	0	35	0	2	14	Missouri
97	3	100	97	3	100	79	12	2	6	1	0	11	1	10	0	7	1	2	0	4	6	Arkansas
187	3	190	187	3	190	120	62	0	4	4	0	14	3	31	0	8	0	7	2	6	....	North Dakota
397	3	400	396	3	399	380	8	5	11	0	0	16	3	20	0	2	1	11	2	4	5	South Dakota
360	20	380	355	20	375	<—315—>			41	19	0	67	4	89	0	19	0	6	0	23	28	Nebraska
308	23	331	308	23	331	232	3	1	35	55	0	68	4	97	0	5	0	....	....	....	....	Kansas
474	125	599	474	125	599	458	20	3	40	78	0	66	9	183	3	10	5	30	2	5	7	Oklahoma
95	21	116	95	21	116	27	38	5	44	3	1	10	0	41	0	1	0	0	0	12	4	Texas
57	12	69	57	9	66	27	7	12	18	5	2	3	14	16	....	2	0	0	0	3	1	Montana
184	20	204	174	20	194	47	53	27	94	2	3	12	3	32	0	1	0	0	0	6	2	Wyoming
37	26	63	37	23	60	37	5	5	13	0	0	2	2	14	....	1	0	1	0	3	1	Colorado
3,509	**415**	**3,924**	**3,477**	**379**	**3,856**	**2,482**	**386**	**74**	**407**	**231**	**6**	**471**	**111**	**826**	**6**	**96**	**21**	**178**	**9**	**104**	**166**	New Mexico
						<—315—>																**TOTAL**
89	14	103	84	14	98	63	24	3	11	4	1	1	3	1	23	0	0	0	0	5	3	**Far West**
147	86	233	147	86	233	16	191	3	23	....	....	1	2	27	....	....	....	....	....	11	....	Idaho
23	46	69	21	45	66	42	18	4	7	....	....	1	2	27	....	2	1	....	....	8	2	Utah
16	27	43	19	24	43	18	31	2	5	7	1	1	3	8	4	5	7	....	0	4	2	Arizona
196	142	338	170	140	310[11]	86	83	1	97	13	0	8	2	77	0	0	0	1	1	10	0	Nevada
220	166	386	220	166	386	89	114	5	185	4	0	7	8	90	0	0	0	0	0	17	18	Washington
206	97	303	189	95	284	25	19	6	66	15	2	19	17	89	0	5	3	2	0	29	6	Oregon
897	**578**	**1,475**	**850**	**570**	**1,420**	**339**	**480**	**24**	**394**	**43**	**6**	**38**	**37**	**319**	**27**	**12**	**11**	**3**	**1**	**84**	**31**	California
																						TOTAL
9,791	**3,487**	**13,293**	**9,336**	**3,424**	**12,760**	**6,473**	**1,863**	**147**	**2,326**	**797**	**97**	**1,739**	**352**	**4,015**	**39**	**356**	**128**	**398**	**19**	**551**	**636**	**GRAND TOTAL**
						<—659—>			<—208—>													
						<—156—>																

FOOTNOTES

[1] Add combination supplies. MASSACHUSETTS: ground 32, surface 45, ground and surface 29; NEW YORK: ground 33, surface 3, ground and surface 47; ALABAMA: dual sources 10; MICHIGAN: ground and surface 3; PENNSYLVANIA: streams, wells, springs 67

[2] WEST VIRGINIA: includes water from coal mines; KENTUCKY: mine water, 6; MARYLAND: mine shaft, 1

[3] Estimated

[4] 111,917 population in 15 communities served by both public and private supplies

[5] Estimated total systems, including mining and industrial villages 1022

[6] Exclusive of institutions

[7] Individual communities in sanitary districts not included

[8] Lime Zeolite 1

[9] Includes gravel pack 8 29

[10] Impounding reservoirs counted under streams. INDIANA, 6; IOWA, 19

[11] Data not available for 30 systems. Table does not include many small supplies not now on record

[12] Totals represent incomplete data

Waterworks Men Meet in Montreal

***Contents in Brief**—The annual convention of the New England Water Works Association, which was held in Canada despite that country's recent declaration of war, included significant discussions on British waterworks practice, new concrete pipe manufacturing methods, ozone treatment and industrial water quality standards. Extracts from these and other papers are included in the following summary.*

WAR CLOUDS NOTWITHSTANDING the New England Water Works Association held its annual convention in Montreal, Canada, on Sept. 12–15 with a registration of 394 members and guests. Forty-seven American manufacturers displayed their products in the exhibit hall. Evidencing the fact that a state of war existed in Canada was the cancellation of an inspection trip of the Beauharnois hydro-electric plant, and the curtailment of visits to the Montreal waterworks, all now under military guards.

Highlight of the technical program was a paper on British waterworks practice by John Bowman, city water engineer of Edinburgh, Scotland, who was unable to attend the meeting because of the European situation. It was with a note of regret, wrote Mr. Bowman, that he found it necessary in include mention of air raid precautions for safeguarding water supplies.

Other papers presented at the three-day meeting dealt with a new method of manufacturing concrete pipe, standards of water quality for industrial uses, experiences in operating an ozone disinfection process, and winter waterworks operations.

New officers elected for the coming year are Percy A. Shaw, president; L. G. Carlton and F. H. Kingsbury, vice presidents; Abel Reynolds, treasurer; F. J. Gifford, secretary.

BRITISH WATERWORKS PRACTICE

The development of systematic water supplies in Great Britain is comparatively modern and dates back not more than a century. London, it is true, had the New River Company in 1613, and a few other companies were founded before 1798, but it was not until about 1845 that proper water supplies were introduced into towns. Most municipalities and authorities owe the introduction of water supplies to the energy and enterprise of private companies. These companies gradually became municipally owned but today there remain some large areas operated by private enterprise. Profits of these companies are limited by an act of Parliament to 6 per cent of the capital.

No reservoir can be constructed without Parliamentary approval and without compensation being made to those who might be considered to suffer loss owing to the abstraction of the water for the supply to the town or area which the reservoir is intended to serve. Parliamentary practice has been to award compensation in the form of a constant quantity of water, usually assessed at one-third of the average available yield. Sometimes the compensation is much higher. There is grave dissatisfaction regarding this practice.

The situation regarding control of groundwater is still more unsatisfactory. Local authorities and water undertakings are controlled so far as abstraction of underground water supplies is concerned, but any private individual owning land may sink wells without permission and may abstract water for any purpose including sale to others.

Much is being done in the way of meeting possible emergencies such as air attacks on cities. In Edinburgh the water department has trained all of its men in gas raid precautions and to work in anti-gas clothing, and every man has an allocated duty in emergencies. Depots have been established at various points to control and deal with repairs in an assigned area. Duplicate mains are being laid and many additional valves are being placed on trunk and distribution mains so that in emergency the water can be shut off in short sections which are damaged by bombs while the rest of the supply is maintained. The government subsidizes approved expenditures to the limit of 50 per cent. —JOHN BOWMAN, *water engineer, City Corporation, Edinburgh, Scotland.*

Discussion — Mr. Bowman's account of compensation in water practice is very interesting. To compensate downstream owners with more than one-half, or even one-third, of the yield of a reservoir would be unthinkable in North America. Compensation in kind rather than money would seem to evidence the social and political influence of early riparian owners.—ROBERT SPURR WESTON, *consulting engineer, Boston, Mass.*

In the matter of compensation for water diverted from industrially developed streams, American practice varies from that of England in that the law here requires money compensation unless compensation in kind can be arrived at by negotiation. In British practice, an Act of Parliament determines the amount of water to be let down the stream. There are some points in favor of both methods, either method as well may lead to disproportionate results.

As to purification of water, the method of slow sand filtration developed in England was first established in this country at Poughkeepsie in 1872 by J. B. Kirkwood. Known as the "English" type filters, they had considerable vogue here for twenty years, and are now the best type under certain conditions and are particularly adapted to New England waters. By all odds they are the safest and most economical in practice where they can be used to advantage. The area required and the first cost

of the plant, however, so militate against them that the "American" rapid type of filter, using chemicals under expert supervision, has practically superseded slow sand filters in this country and is rapidly taking their place abroad.—CALEB M. SAVILLE, *manager and chief engineer, Water Bureau, Metropolitan District Commission, Hartford, Conn.*

I got the impression (from a visit to England) that the British take their engineering more simply than we do, and this confirmed the impression which I gained in China where I worked near a governmental agency headed by a prominent British engineer. I recall his comments on some comparative cost estimates which I had made of two ways of doing some work. He asked, "Do you Americans always estimate the cost of various ways of doing a job?" On answering in the affirmative, he said, "We don't; we try to find the best way of doing a job and then do it that way." I have generally found that the various good ways of doing a job cost about the same; so there may be some justification for the point of view expressed by the British engineer.—T. H. WIGGIN, *consulting engineer, New York City.*

NEW CONCRETE PIPE PROCESS

During a period of twenty years, the experience gained in the use of centrifugally spun concrete pipe has shown the need for improvement, particularly in regard to (1) increasing the density of concrete and consequently the resistance to crushing and tension; and (2) eliminating the deterioration of inside surfaces due to excess water flowing back after the completion of the centrifugal spinning period.

A "superconcrete" process, developed in Switzerland and not yet introduced in America, has accomplished these improvements. Its advantages can be summarized as follows:

(1) The centrifugal machine for making the pipe is so constructed that the mold containing the concrete can be rotated at a speed of up to 8,000 lineal feet per minute, as contrasted to former speeds of 3,500 ft. per min.

(2) At such speed, the density of concrete necessary to permit removal of the finished pipe is obtained in much less time than with other processes. Since both ends of the mold are driven by synchronous motors, all torsion effects are eliminated.

(3) The concrete mixture is not only subjected to centrifugal force but also to vibratory motion to increase the compactness of the concrete. The vibration is produced by a pneumatic hammer which beats against the outside of the rotating mold. The pipe mold is equipped with a filtering cloth on its inside surface, and the wall of the mold is perforated by a large number of small holes through which excess water escapes. This drainage of water during the spinning period gives a perfectly smooth surface to the inside of the pipe because it avoids the return of excess water through the wall of the pipe to the interior when rotation stops, and thus prevents removal of the cement facing which would otherwise occur.

The joint for this type of pipe is of the bell and spigot type, and it provides for a double packing made with hemp impregnated with asphalt. The higher the inside pressure, the tighter will be the first ring of packing squeezed between the walls of the assembled pipe.—C. J. BAILLETS, *chief engineer, Montreal Water Board, in collaboration with* M. ROS, *director of federal office for testing materials, Zurich, Switzerland.*

FEDERAL-AID IN NEW ENGLAND

From information furnished by engineers of the state departments of health in New England, the conclusion is reached that in this area the PWA and WPA work in the water supply field represents a valuable contribution to the majority of communities. Consulting engineers held similar views to those expressed by health department engineers, but they also noted that some activities undertaken (especially in laying mains to supply outlying areas in speculative developments) were not sufficiently needed to justify the expenditure required.

There has generally been comparatively little criticism of the way in which work has been carried on with PWA aid. But the belief was held, in some cases, that because of "red tape" the value of the grant advanced by the federal government was largely absorbed by the increased cost of work and delay in completion of project.

With the WPA work there has been a great deal of criticism, especially as to cost of work and relative inefficiency of the forces employed in such work. Men employed were in many instances not physically able to perform effective work, and the supervision is reported to have been frequently of a character that would not develop efficiency. When labor costs are included, the cost of water supply work has been several times greater than what would be expected if contract or regular force account methods had been used instead of relief labor.—W. W. BRUSH, *editor, Water Works Engineering, New York City.*

Discussion—Water supply facilities in Massachusetts have been definitely improved with federal funds. Under the PWA program, projects have been undertaken whose aggregate cost is estimated at $24,000,000. Among these projects are included: 17 new waterworks systems; 19 distribution main extensions; 16 additions to supply sources, conduits and storage; 12 treatment works and additions.—F. H. KINGSBURY, *senior sanitary engineer, Massachusetts Department of Public Health, Boston, Mass.*

Municipal public works authorities who are quick to condemn high costs and inefficiency on WPA work should not speak too loudly until they are certain that their part in the administration of WPA projects leaves nothing to be desired. In some instances, local authorities are open to criticism because of their lack of ability to effectively plan and organize work to be done by force account methods using relief labor. Municipal officials have been slow to recognize that the principles and practice used in handling contract work—long the established practice in many places—do not necessarily apply to force account operations. It takes time and experience to develop new techniques and the period of adjustment with its attendant confusion will undoubtedly reflect inefficiency.—E. J. CLEARY, *associate editor, Engineering News-Record, New York City.*

INDUSTRIAL WATER QUALITY

Typical standards of water quality for general industrial purposes have been set up on the basis of listing maximum tolerable concentrations of impurities (Table I). These maxima were obtained mainly from specific work and experience in the field of industrial applications, but data are also included from official standard-

ization programs of special industries and of national trade and professional associations.

These standards are based on the usual limits for normal practice, and usually these are the values beyond which corrective treatment begins to pay for itself. The standards do not imply that operation with higher impurity content is impossible or necessarily inadvisable, because individual operating practices are fixed by many economic factors other than water quality alone and therefore subject to special consultation.—F. J. LAMMERS, *International Filter Co., New York City.*

SAFEGUARDING WATER SUPPLIES

There is a growing opinion that waterworks operators should be responsible for the quality of the product they sell up to the consumer's tap; there is much merit in the viewpoint. Too many water purveyors—and even public health officials—concentrate on the delivery of a safe water to storage reservoirs and neglect potential pollution hazards to the distribution system. Others take the position that a safe supply delivered to the consumer's premises is the extent of their responsibility.

It cannot be assumed that water in a distribution system will always flow in one direction, namely, from the supply source to the consumer. Unless proper supervision is exercised over water systems on consumers' premises, and unless adequate pressures are maintained in the public system, there may be periods of backflow.

Water utility operators have a definite responsibility of knowing what pollutional hazards exist on a consumer's premises and should not supply service unless precautionary measures are taken to protect the public supply. Other public utilities are most exacting in determining the use that is made of their services—why should not waterworks officials take a similar stand?—ARTHUR GORMAN, *engineer of water purification, Dept. of Public Works, Chicago, Ill.*

WATER OZONATION

The water supply of Delhi, N. Y. (population 1,800) was subjected to ozone treatment during the period of 1928–1935 and then abandoned. Ozone disinfection was originally adopted because of citizen objection to chlorination. The apparatus was rated at a capacity of 86 grams of ozone production per hour, equivalent to about 0.7 ppm for a flow of 30,720 gal. per hour. Sixty grams of ozone were supposed to be produced per kilowatt-hour of electricity whereby the cost of the ozone would be 20 to 30c. per pound based on a low power charge of 2c. per kw. A dose of 0.5 ppm of ozone was held to be adequate by the manufacturer, but this was proven to be insufficient.

It is difficult properly to appraise the results secured at this plant because part of the failure was due to neglect of equipment and improper coagulation of the water to be filtered, and partly due to difficulties inherent in the ozonation equipment. It was

TABLE I—STANDARDS OF WATER QUALITY CLASSIFIED ACCORDING TO INDUSTRIAL APPLICATIONS

	Boiler Feed Water			Brewing		Canning	Carbonated Beverages	Cooling Water	Pulp & Paper					Raw Water Ice	Tanning	Textile
	0–150 lb.	150–250 lb.	250 & up lb.	Light	Dark				Ground wood	Kraft	Soda & Sulfite	Bleached	Rayon			
Turbidity	20	10	5	10	10	10	2	50	50	25	15	5	5	5	20	5
Color							10		20	15	10	5	5	5	10–100	5–20
Dissolved oxygen* in cc/liter	2	0.2	0													
Color plus O_2 consumed in ppm	100	50	10				10									
Odor (or free chlorine) " "				0	0	0	0							0		0
H_2S " "	10	5	0	0.2	0.2	1	0.2	5								
Total hardness ($Ca\ CO_3$) " "	75	40	8			25	250	50	180	100	100	50	8		50–135	10
Methyl orange alkalinity " "				75	150 & up		50–100						50	30–50	135	
Ca " "				100–200	200–500											
Fe " "				0.1	0.1		0.2	0.5	1.	0.2	0.1	0.1	0.05	0.2	0.2	0.2
Mn " "				0.1	0.1		0.2		0.5	0.1	0.05	0.05	0.03	0.2	0.2	0.2
Fe plus Mn " "				0.1	0.1	0.2	0.3	0.5	1	0.2	0.1	0.1	0.05	0.2	0.2	0.2
Al_2O_3 " "	5	0.5	0.05										8			
SiO_2 " "	40	20	5										25	10		
Cu " "													5			
F " "				1	1	1	0.2									
CO_3 " "	200	100	40													
HCO_3 " "	50	30	5										60			
OH " "	50	40	30										8		8	
Total solids " "	3000–1000	2500–500	1500–100	500	1000		850			300	200	200	100	300		
Na_2SO_4—Na_2CO_3 ratio	1 to 1	2 to 1	3 to 1													
$CaSO_4$				100–200	200–500											
pH	8.0 & up	8.5 & up	9.0 & up	6.5–7.0	7.0 & up											
Potability				U.S.T.	U.S.T.	U.S.T.	U.S.T.							U.S.T.		

Values represent standard A.P.H.A. determinations. * Determination by Winkler method. U.S.T. means U.S.Treasury standards for drinking water.

found possible, however, effectively to disinfect properly filtered water when sufficient ozone was added. The water so treated had no residual taste or odor, and organic matter was bleached and oxidized. However, an important disadvantage is the lack of satisfactory quantitative test for residual ozone which permits accurate control of dosage.

Because of excessive cost of operation and necessary replacement of inadequate equipment, dissatisfaction was sufficient by 1935 to lead to the installation of automatic, solution-feed chlorinators.—E. R. Cox, *chief, Bureau of Water Supply, Division of Sanitation, New York State Department of Health, Albany, N. Y.*

WINTER WATERWORKS OPERATION

The following notes on winter waterworks operation are based on experiences in the town of Temiskaming, Que., where the thermometer at times drops to 60 deg. below zero. Owing to local conditions (labor turnover at a large industrial plant) there are quite a number of temporary services. One way of protecting these installations is first to inclose the pipe in a wooden box some 8 in. square. This is inclosed in a second box with a removable cover about 30 in. wide and the surrounding space is filled with sawdust. Electrical heat is provided by using a "soil heating cable" which is available in 60-ft. lengths for 115 volt current. The cable usually heats itself to 175 deg. F. Sometimes two or more cables are spliced together; this, of course, reduces the temperature of the cable but the heat developed is adequate to prevent freezing. Sixty-foot lengths of cable use about 3 amp. of current at 110 volts.

When boxes are not used and temporary services cannot be placed more than a few inches below the ground, the soil heating cable is placed in a conduit laid parallel and close to the surface itself. The cost of operation is cheap because current charges are only one-half cent per kilowatt-hour, and on this basis a 60-ft. length of cable in constant use costs $1.10 a month.

Daily inspection is maintained on all hydrants in the winter. When frozen, a 60-ft. length of soil heating cable is wrapped about the exposed part of the hydrant above ground. The heat thus generated apparently travels down through the hydrant barrel and the spindle, thus thawing the ice which, when started, is removed by opening the hydrant and discharging it through the outlet. During this process the hydrant is covered either by canvas or other protective means.

A wood stave pipeline, exposed on the surface, causes trouble in winter because of leakage and consequent ice formation on streets, sometimes to a depth of 4 ft. Lengths of the cable are installed so that open channels are maintained to catchbasins. The cables are laid in conduits and throughout the winter will maintain an open channel in the ice about 18 in. in diameter.—ALLEN K. GRIMMER, *town manager, Temiskaming, Quebec.*

LEAD-POISONING

Up to a few years ago the notion was generally prevalent that regardless of the amount of lead taken in by the body, it gradually accumulated until ultimately lead poisoning resulted. The work of recognized medical authorities on this subject has shown beyond doubt that the human body has means of effectively disposing of small quantities of lead. Medical research together with practical experience in a number of communities indicates that the U. S. Treasury limit of 0.1 ppm lead in water is a decidedly safe limit. It can be said safely that there is little, if any, danger from waters aggressive to lead in the United States outside the New England area.

In a general way, very soft waters attack lead sufficiently to require protective measures. Judgment cannot be made on pH value alone, and some waters with a very low pH are less corrosive than others because of different composition. High oxygen and free carbon dioxide content and low hardness add to the corrosiveness of the water, and certain salts in the water are inhibitors. Likewise, stable organic matter in waters that might otherwise be corrosive may deposit on the pipe walls, forming an adherent protective coating that prevents solution of lead in water. On the other hand, soft waters from peaty moorland sources contain organic acids in addition to carbonic acid, which increase the attack and do not form protective coatings.

In a water with a low pH value, high oxygen and carbon dioxide content, and hardness below 50 or 100 ppm, lead services should be used with care. Such waters in a public supply are rare, but where they are encountered, either tin-lined lead pipe or a corrective treatment should be employed. These waters may be successfully treated with lime or sodium silicate, or a combination of both.—ROBERT L. ZIEGFIELD, *Lead Industries Association, New York City.*

DOUBLE FILTRATION

The unsatisfactory character of the raw water and the difficulties inherent in properly treating the Lawrence, Mass., water supply with slow sand filters (originally installed in 1893) led to improvement undertaken in 1937. Although abandonment of the Merrimack River source of supply for a new and much less polluted supply would have been desirable, the cost involved was too high. Accordingly, it was decided to retain the old covered sand filters for secondary filtration and add a rapid sand filter plant for primary filtration.

Double filtration has been employed in a very few cases. Perhaps the best known examples are the old Hudson River filter plant at Albany, N. Y., now abandoned, and certain of the London, England, plants. In the London plants, the primary filters are of the rapid sand type, but they are used without coagulants. The Lawrence rapid filters, however, employ coagulation and afford complete treatment, the slow sand filters being retained primarily as a safeguard against the possible failure of the primary filters to produce a uniformly safe supply. The plant was put in operation in December, 1938. —A. L. SHAW *and* E. SHERMAN CHASE, *Metcalf & Eddy, consulting engineers, Boston, Mass.*

Discussion—Experience in the operation of the Lawrence rapid sand filters with chlorination since their completion has shown that the effluent has been of satisfactory quality and the question of the necessity of the continued use of the covered slow sand filters for double filtration has been questioned. In answer the Massachusetts Department of Public Health has stated that ". . . while the Merrimack River continues to be a source of water supply of the city of Lawrence and until water from an unpolluted source may be obtained, the department must insist upon the use of the complete works . . ."—F. H. KINGSBURY, *senior sanitary engineer, Massachusetts Department of Public Health, Boston, Mass.*

Sewer Design and Construction–1939 Model

E. J. CLEARY
Associate Editor, Engineering News-Record

Contents in Brief—Cranston, R. I., largest city in the country without sewers, is installing facilities to serve 50,000 people. Here is an opportunity to examine up-to-the-minute sewer design and construction practice, along with job management methods using relief-labor.

PERFECTED sewer design methods, the use of new materials and modern equipment, and the operation of a major construction project with relief labor find expression in the installation of a city-wide sanitary sewer project now under way in Cranston, R. I. This city of 50,000 people holds the rather dubious distinction of being the largest municipality in the United States without sewerage facilities. Correction of this deficiency and the installation of a treatment plant will cost in the neighborhood of $6,000,000 toward which the WPA has agreed to contribute $3,500,000. Thus the project assumes added distinction in being one of the largest relief-labor jobs ever to be undertaken.

It is a rare occasion today when an engineer can design and construct a complete sewerage system. The Cranston situation, therefore, presented an opportunity as well as a challenge. The absence of any sewerage facilities whatsoever presented the engineers a free hand to design what, in their judgment, would be an ideal system. In so doing they were face-to-face with a challenge to incorporate in the design all of the lessons learned from experience gained in the last century or more of sewer building. In this respect, then, the work at Cranston holds special significance for the sanitary engineer for what it reveals in regard to 1939 standards of sewer design and construction.

Of equal interest, in view of the fact that a major job of this character is being undertaken with relief labor using force account methods, is the organization of personnel and the management of operations. Administration of the Cranston project involves the cooperation and integrated effort of three parties, namely: (1) the sewer commission of the city which, as sponsor, furnishes tools and equipment, most of the materials, and equipment operators; (2) the consulting engineer, who directs and controls all engineering supervision and inspection; and (3) the Work Projects Administration, which supplies labor (except equipment operators) and construction superintendence. The manner in which this complicated machinery has been geared for action is in itself worth study.

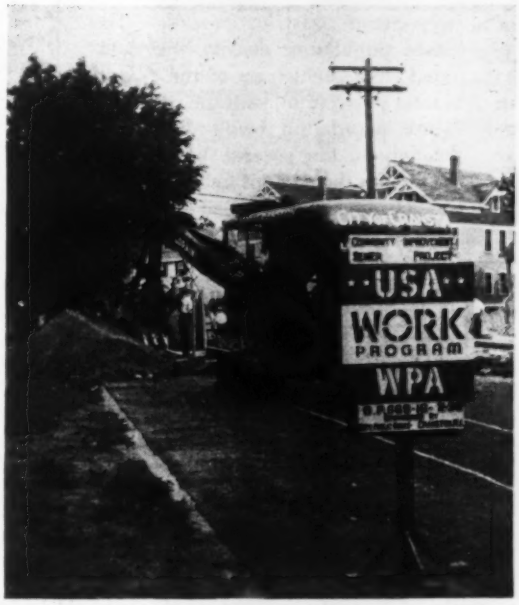


Fig. 1. Efficient job management combines modern construction equipment with relief labor activities on the Cranston sewer project.

Before launching into the design and construction phases of the project, a brief background picture is in order: Cranston is a city adjacent to Providence, the state capital of Rhode Island. While it is almost exclusively a residential city, it does contain five large industrial establishments. Two streams flow through the city, and it is bounded on the east by Narragansett Bay. Since the soil in this area is sandy and highly absorbent, thousands of septic tanks and cesspool installations, which have been used for sewage disposal, have been operated with fair success. Increasing population growth, however, long ago limited the desirability of these devices which overflowed into water courses and otherwise constituted public nuisances.

Agitation for sewerage facilities, which began in 1923, resulted in the formation of a citizens' committee in 1928, which sponsored a preliminary engineering report and plan. When a proposal to carry out this plan was put to a vote, however, it was defeated.

The opportunity to obtain a sizable WPA contribution —about $3,500,000—in November, 1938, led to the passage of a state enabling act whereby a city sewer commission was created. The commission was empowered to spend the proceeds from a $2,500,000 bond issue, which amount represents the sponsor's share of the federal relief project. The bonds, issued by the city, are not included as part of the city's bond indebtedness, and the issue will be financed from sewer rentals. Should there be a deficiency in revenue to meet financial obligations, a special assessment can be levied on property.

The sewerage improvement plan calls for the installation of about 87 miles of laterals and trunk lines, nine

pumping stations and construction of a 9-mgd activated-sludge treatment plant. The sewer lines, varying in size from 8 to 36 in., will include the use of vitrified clay, reinforced concrete, asbestos-cement and cast-iron pipe.

The description of the sewer project which follows is divided into two major sections, treating, respectively, design and engineering, and construction procedure. No information is available on the treatment plant, which is now in the preliminary stages of design.

Design and Engineering

TOPOGRAPHY in Cranston divides the city in three logical drainage areas, each of which is separately considered both for design and construction purposes. Sewers in the three areas are planned so that the flow from each is brought together in a common trunk line that will terminate at the sewage treatment plant. It was impossible to secure gravity flow throughout without involving excessively deep trunk sewers and consequently all of the sewage will be pumped at least once; in some instances the same sewage will be pumped two or three times. Accordingly, provisions have been made for the use of nine pumping stations varying in size from 150 to 6,000 gpm; all of the stations are equipped with stand-by units equal to the rated capacity of the pumps, and practically all operations will be automatically controlled at each station.

To determine the size of sewers the following method was used by Fay, Spofford & Thorndike, consulting engineers:

Starting at the highest point in the system, a small drainage area involving several streets was plotted on a large-scale map (1 in. = 500 ft.). The size of this area in acres was then determined using a planimeter; residential and commercial and industrial portions of the area were separately determined. The average population density of the area (expressed on the basis of persons per acre) was then determined by use of census enumeration district records. The future population density was computed from predictions of the growth in total population, with the predicted future population being distributed throughout the several portions of the area so that the future densities of population corresponded for any given area with the total future population predicted for that area.

With the population figures and the number of acres determined, the total expected flow from the residential portion of the drainage area can be found from the diagram shown in Fig. 2. To this quantity was added the computed flow from commercial and industrial establishments as well as an additional amount for infiltration. The commercial and infiltration allowances were determined by empirical methods established by the consultants and based on long experience records.

With the total flow thus established, the capacity of the outlet sewer for the drainage area under study was determined using the Kutter formula. (See diagram, page 94, Vol. I, *American Sewerage Practice*, Metcalf & Eddy, 1914 edition). An n value of 0.015 was used for vitrified clay pipe, and 0.013 for concrete and asbestos-cement pipe.

An example of a typical calculation for sewer capacity is shown below. Reference should be made to Fig. 2, which includes diagrams and tables prepared expressly for the Cranston design.

Required: the maximum flow and size of sewer for an area of 49 acres; 4 acres are occupied by commercial business, 5 acres are given over to industrial uses and 40

Allowance

Water Consumption. Average daily rate 95 gallons per capita per day. Maximum daily rate 175% of average daily. Maximum hourly rate 140% of maximum daily.

Domestic Sewage. 70% of water consumption reaches sewers. Maximum sewage rate including allowance for concentrated flow from small areas 285 gallons per capita per day for 5 acres and decreasing to 245 gallons per capita for areas of 100 acres or more.

Infiltration. 30,000 to 50,000 gallons per day per mile of sewer for low land and 20,000 to 35,000 gallons for high land.

Commercial Sewage. 25,000 gallons per day per acre.

Industrial Sewage. Variable allowance.

Infiltration
Cubic Feet per Second per Acre

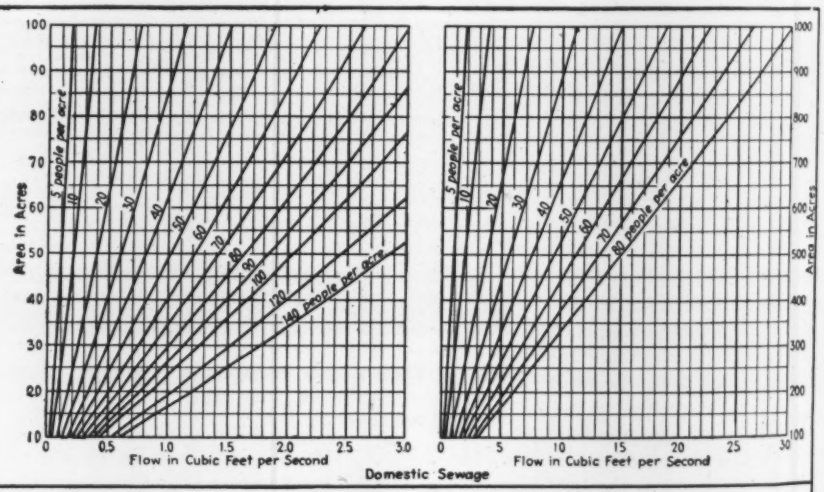
Size of Pipe	Low Land	High Land
8	.0014	.0009
10	.0014	.0010
12	.0015	.0010
15	.0015	.0011
18	.0016	.0011
20	.0016	.0011
24	.0017	.0012
27	.0018	.0012
30	.0019	.0013
33	.0019	.0013
36	.0020	.0014
39	.0020	.0014
42	.0021	.0015
45	.0022	.0015
48	.0022	.0016
51	.0023	.0016
54	.0023	.0017

Table A

Commercial Sewage
Cubic Feet per Second

Ac.	CFS	Ac.	CFS
1	.039	6	.232
2	.078	7	.271
3	.116	8	.310
4	.155	9	.349
5	.194	10	.388

Table B



Computations for Separate Sewers

Section	Portion of Sewer: Location or Street	Stations or Limits: From	To	Adjacent Area: Total Acres	Industrial Acres	Commercial Acres	Domestic Acres	Population: Per A	Total	Total Tributary Area: Industrial Acres	Commercial Acres	Domestic Acres	Population: Per A	Total	Maximum Volume of Sewage, Cubic Feet per Second: Industrial	Commercial	Domestic	Infiltration	Total	Proposed Sewer Data: Pipe: Size	Slope	Velocity Full	% Actual	Depth of Flow	Length	Invert Elevation: Upper End	Lower End	Cut: Upper End	Lower End	Average
a	Westview Av.	Northview Av.	Palmer St.	49	5	4	40	27	1080	5	4	40	27.0	1080	.156	.155	.440	.044	.795	8"	.008	2.35	2.72	6.37"	850	120.00	113.20	7.5	11.5	9.5
b	Park Av.	Palmer St.	River St.	37	3	7	27	19	513	8	11	67	23.8	1593	.248	.429	.650	.086	1.413	10"	.007	2.22	3.02	8.1"	1260	113.05	104.21	11.5	8.5	10.0
c	Church St.	South St.	Cranston St.	29	8	1	20	25	500	16	12	87	24.1	2093	.496	.468	.852	.115	1.931	12"	.0045	2.45	2.84	9.7"	1880	104.04	95.58	8.5	12.0	10.25
d	George St.	Chestnut St.	Colonial St.	63	-	10	53	21	1113	16	22	140	22.9	3206	.496	.858	1.300	.178	2.832	15"	.005	2.35	2.72	12.0"	1760	95.33	90.05	12.0	11.0	11.50

Fig. 2. Calculations for the design of the sewers are simplified with these diagrams and tables.

acres are devoted to residential purposes. The predicted population is 27 per acre.

1. From the diagram in Fig. 2, 27 people per acre in a drainage area of 40 acres will produce a maximum flow of 0.440 cfs.

2. From Table B in Fig. 2, a commercial area of 5 acres will produce a maximum flow of 0.155 cfs.

3. Data from industrial plants indicate a daily flow of 0.156 cfs.

4. From Table A in Fig. 2, the infiltration to be expected in an 8-in. pipe = 0.0009 cfs per acre; total infiltration equals 0.0009 x 49 acres = 0.044 cfs.

5. The sum of these four constituents of the total flow is 0.795 cfs.

6. Using the Kutter formula, and n = 0.015 for vitrified clay pipe, it will be found that an 8 in. pipe laid at a slope of 0.008 has the necessary capacity. In fact this sewer line will slightly exceed requirements by carrying 0.82 cfs at a velocity of 2.53 ft. per second when flowing full.

Using the diagrams and tables, the calculations for sewer sizes are methodically arranged for computation and checking with the aid of the form shown in the lower part of Fig. 2.

Specifications and standards

For a project so large and complex as the Cranston system, standard procedures for construction and specifications for structures were carefully developed by the consulting engineers. These are shown in Fig. 3.

Of particular interest are the details of the manhole construction which calls for poured-in-place concrete structures using sectional steel forms. The base of a standard manhole is a 12-in.-thick plain concrete slab 6.5x6.5 ft. square. On this base a brick-lined invert is laid at the proper grade connecting with the inlet and the outlet pipe. Then a 12-in. circular brick wall is laid up, the brickwork being carried two courses above the top of the highest pipe in the manhole. On top of this brickwork is poured the monolithic con-

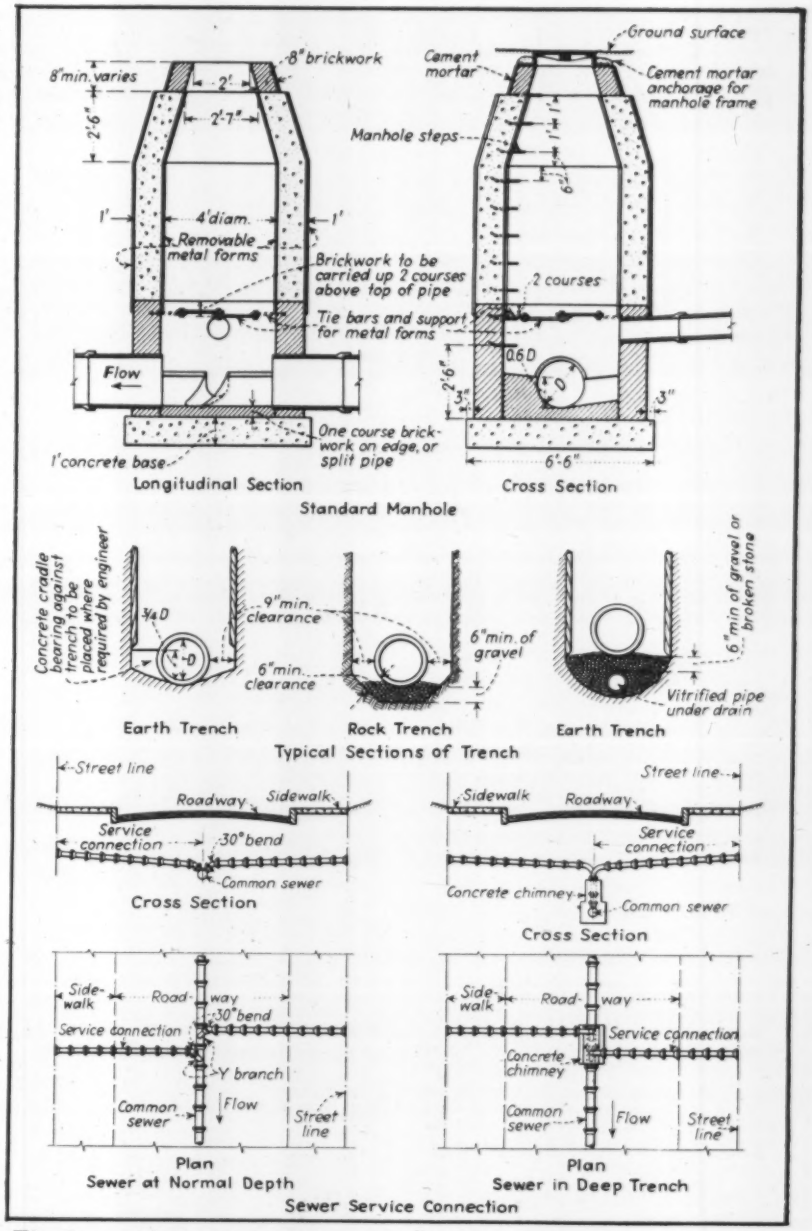


Fig. 3. Standard designs for the design and installation of sewer structures.

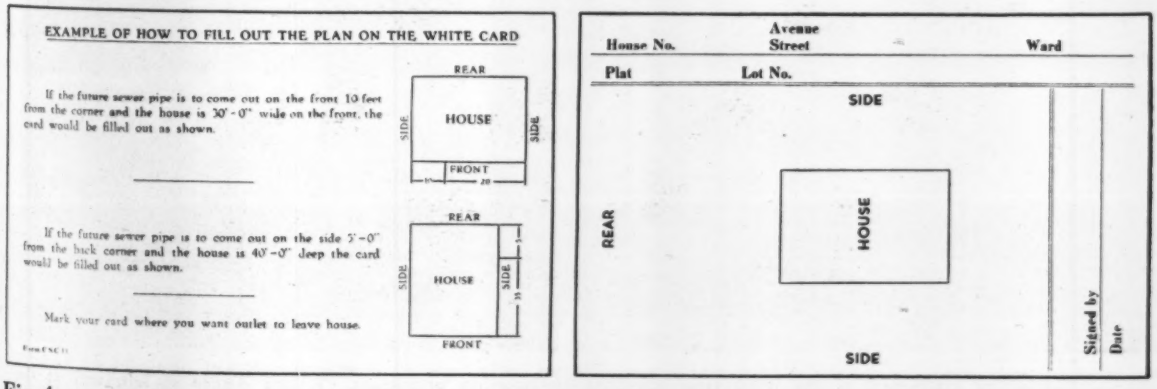

EXAMPLE OF HOW TO FILL OUT THE PLAN ON THE WHITE CARD
If the future sewer pipe is to come out on the front 10 feet from the corner and the house is 30'-0" wide on the front, the card would be filled out as shown.
REAR
SIDE
HOUSE
SIDE
FRONT
10'
30'
If the future sewer pipe is to come out on the side 5'-0" from the back corner and the house is 40'-0" deep the card would be filled out as shown.
REAR
SIDE
HOUSE
SIDE
5'
35'
FRONT
Mark your card where you want outlet to leave house.
House No.
Avenue Street
Ward
Plat
Lot No.
SIDE
REAR
HOUSE
SIDE
Signed by
Date

Fig. 4. Cards mailed to property owners by the Sewer Commission to obtain data concerning house connections.

crete shell which forms the manhole wall. The top of the concrete is kept at least 14 in. below the finished grade of the street so that the manhole frame can easily be set to exact elevation using brick and mortar. In areas where groundwater infiltration is not serious, an 8-in. thickness of wall is used instead of 12-in.

The reason why a brick wall instead of concrete is used for the first three feet or so of the manhole is because this procedure makes it unnecessary to place bulkheads in the forms to accommodate the inlet and the outlet pipes. This is an operation calling for skilled labor which is at a premium on WPA work in this area. In fact, the shortage of brick masons on WPA payrolls and the desire to make more work for common labor led to adoption of concrete manhole construction for this job.

Also shown in Fig. 3 are the standard methods specified for the laying of pipe under various trench conditions, and for making service connections. These details will be described in the section of the article dealing with construction methods.

Construction Procedure

THE FOLLOWING deals with job organization and construction methods. It should be emphasized at this point that the Cranston project involves close cooperation among three agencies, namely, the sewer commission, which supplies tools and materials and operators of equipment, the Work Projects Administration, which supplies and controls all other labor, and finally the consulting engineers, who direct and control all engineering and supervision. Upon careful integration of effort, therefore, depends the efficiency of the work.

Job organization

To expedite operations, six complete and independent construction units have been set up. Each unit includes the following personnel and equipment except as noted.

160 men (working in two 6-hr. shifts with 80 men to each shift).
4 civil engineers (2 on line and grade and 2 on inspection).
1 backhoe or a ¾-cu. yd. trenching machine.
1 crane equipped with ¼-cu. yd. clamshell bucket.
1 portable 210-cu. ft. air compressor.
1 portable 105-cu. ft. air compressor for service connections (serves two units).
1 tractor equipped with sheetpile pulling rig and scraper blade for backfilling (serves two units).
2 centrifugal pumps (2-in. and 4-in. sizes).
1 one-bag concrete mixer (serves two units).
2 25-gal. heaters for melting joint compound.
3 pneumatic sheetpile hammers.
Miscellaneous small tools, viz., shovels, tampers, lanterns, etc.

In addition to the equipment provided for each unit, the sewer commission supplies trucks and special equipment to the various units as required.

The activity of the six units is under the direction of a general superintendent employed by WPA, and all the foremen (numbering 3 in each unit) report to him for instructions. The equipment operators take orders from the general superintendent but they are employed and paid by the city which owns the equipment. The engineers and inspectors are also paid by the city but they take orders from and report only to the resident engineer of Fay, Spofford & Thorndike, who hired them.

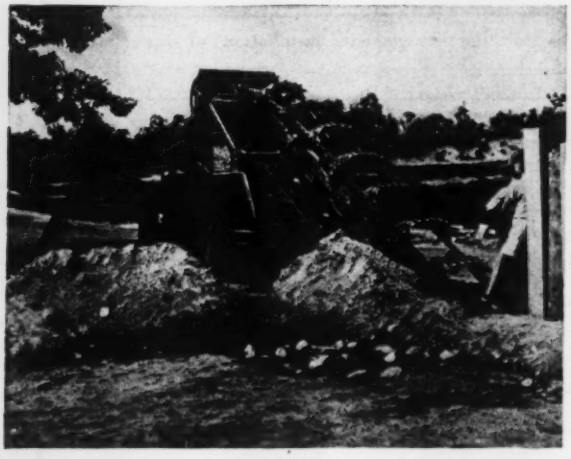
The units work independently of each other on sections of the sewer in different locations in the city, but they are not widely separated. The work to be done in any one section can be classified into three divisions which follow in sequence, namely: (1) construction of the sewer; (2) installation of house services and manholes; and (3) street repair and clean-up.

Field location of sewer

Before a unit is put to work in a section, the sewer commission mails cards to each property owner in the area. The owner is requested to provide information on this card concerning the location and depth of his plumbing drainpipe and the depth of the cellar measured from the top of the foundation wall. This provides data for locating wye connections in the sewer. To aid the owner in supplying the proper data a sample yellow card is inclosed with the white return card illustrating how the information should be recorded (Fig. 4).

Meanwhile, test pits are dug across the entire width of the street on which work is to be started. In this way all existing underground services are accurately determined. With this information on hand, the survey crew is ready to go to work.

Each survey party (there are two or three parties at work all of the time) includes three men. They stake



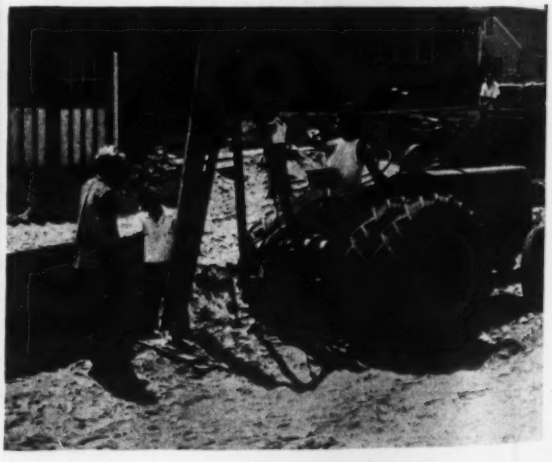


Fig. 5. Labor-saving equipment of the latest type expedites construction operations. Trench digger at left, and at the right, a tractor equipped with a sheetpile pulling rig.

out the location of the sewer centerline and the position of the manholes. Following this an accurate profile of the ground surface at the centerline of the sewer is obtained and then the party chief computes the digging cuts to be made by the machine.

Specifications have been set up for the general location of the sanitary sewer line, based on the width of the street, the position of existing gas and water pipes and the possibility of future installation of storm drains. On a 40-ft. street, for instance, the sewer is placed 2 ft. off the centerline of street on the side nearest to the gas main (gas and water mains are already installed on opposite sides of streets in Cranston); on a 50-ft. street a 3-ft. offset is used, and for 60-ft. streets a 4-ft. offset is specified.

Construction gets under way

With field locations established, one of the construction units is moved on the street. A trenching machine (or backhoe) is immediately set to work making a 4-ft.-wide cut along the pipeline; depending on the ground conditions the machine will dig to a depth of from 5 to 9 ft. As soon as a depth is reached where the trench sides would cave in, wood sheeting is set in place.

The sheeting is 2 x 8-in. spruce, of 12-ft. lengths. It is driven into place using pneumatic hammers, the air for which is applied from a 210-cu. ft. portable compressor; the bottom of the sheeting is driven to the approximate grade of the pipe. A crane with a ½-cu. yd. clamshell bucket then moves into place and excavates the trench to approximate grade.

As soon as the machine digging operation is completed, the line and grade crew that forms part of the engineering personnel comprising the construction unit set up batter boards every 20 ft. on which are established the line and grade. To insure accuracy no final line or grade is established until all sheeting has been driven, machine digging is completed and the pipe laying is ready to start.

The pipe laying crew first trims the trench to accommodate the pipe at the exact grade and then sets the 3-ft. length pipes. All pipe joints are yarned and poured with a bituminous compound in the trench after the pipe is placed. Joining lengths of pipe before they are in place is not favored because of the possibility of

Fig. 6. Portable heater keeps joint compound at the proper temperature.

irregularities in the alignment of sections due to improper centering. In bad ground and in rock trenches, special precautions are taken to prevent pipe movement or breakage. Where the soil is unstable, the unstable material is removed and replaced with gravel ballast, and the pipe laid in a gravel cradle. A concrete cradle is used in deep cuts when the depth of backfill would cause a heavy loading on the pipe or where a heavy loading from causes other than the backfill may be anticipated. In rock trenches the pipe is laid on a 6-in. gravel bed. These details of construction are shown in Fig. 3.

Backfill carefully made

After the pipe is laid and the joints poured, backfilling operations are begun by carefully packing earth under and around the sides of the pipe with a railroad-type tamping ram. This operation is continued until about three-quarters of the pipe is covered. Then at least one-foot depth of cover is added over the pipe and solidly packed with iron hand tamps, care being taken to remove all stones which might fracture the pipe. The balance of the open trench is filled by hand and machine and puddled with water.

With backfilling completed, the sheeting is pulled using an A-frame and stiffleg attached to a tractor (Fig. 5). A cable operating from a power takeoff passes over the pulley on the A-frame, and this cable is attached to the clamp which grips the sheeting. After the sheeting is out, a bulldozer blade is attached to the tractor and the trench is banked with earth.

Following the installation of the sewer in the street, the first division of the work is completed and the construction unit and equipment moves on to the next street. Service and clean-up crews complete the final two phases of the operation, namely, installation of house services, street repair and general clean-up. House services of 6-in. pipe are laid from the sewer to the property line at the city's expense, but the home owner is required to make a connection at his own expense.

Making service connections

Location of wyes for house services is the responsibility of the inspector on the job, who is assisted by the line and grade party. Using information previously gathered in the card survey of homes in each block, the inspector locates a point on the curb line opposite the place where the sewer connection is to enter the house. When the sewer is being laid, this point is transferred to the centerline of the sewer and a wye is placed in the line at the first pipe length behind this point. The reason why the wye is dropped back is to insure adequate opportunity for small adjustments. The location of the wye is then noted by the inspector in reference to the stationing, and this information is transferred to the record plans prepared by the engineers. The exact location of the wye is also obtained by the line and grade party which takes at least two measured ties from adjacent houses or lot bounds.

Trenches for the house connections are dug by hand and pipe is laid from the wye to the property line. Before the trench is backfilled the line-and-grade party, working with the inspector, obtains the invert elevation of the end of the pipe at the property line and, in addition, locates the position of the pipe with three reference ties to the house. This important record information is immediately placed on file with the sewer commission where it is available for public inspection.

On lots which are vacant the house service pipe to which future connections will be made is carried to the property line at a point midway between the lot lines. The pipe is laid at the same depth as that for adjacent houses, and its location is tied-in with at least two measured distances from visible lot bounds.

Two types of service connections to the main sewer are employed, depend-

ing on the depth of the sewer in relation to the house connection. In sewers at normal depth in the street (up to 11 ft.) the connection is made with a wye section turned 45 deg. or less from the horizontal plane when it is laid. In a deep trench (more than 11 ft.) a wye with a 30-deg. bend section and vertical pipe is used. This is built vertically upward to the desired elevation and the take-off is made with a long radius elbow; the vertical section up to the elbow, called a "chimney," is encased in concrete. Both types of connection are illustrated in Fig. 3.

General clean-up and the installation of bituminous macadam surfacing over the trench cut completes the job. The street repair consists of first excavating the trench area for a depth of 8 in., and then filling this cut with 6 in. of crushed gravel. On top of this is placed a 2-in. surface of tar concrete to complete the pavement.

The men in charge

Representing the city of Cranston on this project are E. W. Higson, L. B. Ballou, Jr., and J. F. McMaster, members of the sewer commission, and Elton F. Durfee, city superintendent of construction and commissioner of public works. Merrill D. Ambrose is manager of the commission.

The consulting engineers are Fay, Spofford & Thorndike of Boston, for whom Ralph W. Horne, a partner in the firm, is in direct charge. C. W. Riva is resident engineer on the job, and Edward Shay is office manager.

For the Work Projects Administration Raymond E. Massart is resident engineer, and Frank Mildner is superintendent of construction.

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Bridge Design Competition Announced by A.I.S.C.

Students in engineering and architectural schools throughout the United States have been invited to participate in the annual bridge design competition for which the American Institute of Steel Construction is offering a first prize of $200, a second prize of $100 and a third prize of $50. Design of a steel foot bridge to carry pedestrian traffic across a parkway to a recreation area on one side of the parkway is the design problem. Drawings must be in the institute's executive offices in New York City by Feb. 5, 1940.

Mississippi River Pollution Reduced by Twin Cities Plant

Contents in Brief—Placed in operation only a year ago, the Minneapolis-St. Paul sewage treatment works has already proved successful in reducing river pollution. Results show large increases in dissolved oxygen and reductions in bacteria and biochemical oxygen demand.

ALTHOUGH the new sewage treatment works for St. Paul and Minneapolis were only put into service on June 1, 1938, and operation even then was interrupted occasionally by conditions incident to breaking in a new plant, the effect of their operation in improving conditions in the Mississippi River was very soon evident, as explained in the 1938 report of the Minneapolis-St. Paul Sanitary District.

After the early part of June, practically none of the Minneapolis sewage was being discharged into the river above the lock and dam, and by the middle of July nearly all the St. Paul sewage was also being delivered to the treatment works. There was some slight gassing through the summer in the pool above the dam, due to the accumulated sludge deposits, but it was much less than in former years, and it was expected that by the summer of 1939 these old deposits would be stabilized and covered with the river silt. Floating scum, sleek and large masses of sludge which in previous summers covered 50 per cent of the area of this pool, were no longer in evidence and the former foul odors had disappeared.

Clean water passed through the several power stations and the government dams instead of the foul and ill-smelling liquid of former years, and there was less need for cleaning the plants. One power station reported a considerable saving in the amount of chlorine required to keep the boiler feedwater (taken from the river) in satisfactory condition. Furthermore, favorable statements have been made by boat owners, as the river was in such condition in former years that there was little pleasure in this recreation. Game fish were also in evidence, while heretofore the river had been too polluted to support even the rougher forms of fish life to any extent.

For the month of August in 1937 and in 1938 the average analytical records at the Twin City dam are as shown in the accompanying table. The large increases in dissolved oxygen content and large reductions in bacteria and biochemical oxygen demand verify the rapid recovery of the river above the treatment works. The condition of the river below the plant was also good during the summer of 1938, although full 24-hour treatment was not started until July 20. The sewage and packing-house wastes from South St. Paul and Newport were still being discharged untreated about three miles below the plant, but plans were under way for treatment of these wastes.

An exceptional amount of pollution discharged into the Hastings pool last summer, 1938, resulted in the dissolved oxygen content dropping somewhat below the 2-ppm standard for this section of the river. In general, however, the nuisance conditions in this pool were less than in previous years and the dissolved oxygen did not become completely exhausted for several months, as has been the case in recent years before the treatment was built.

RIVER CONDITIONS AT TWIN-CITY LOCK AND DAM

	Aug. 1937	Aug. 1938
Dissolved oxygen, ppm	0.35	6.1
B.O.D. ppm	3.25	2.0
Turbidity, ppm	15.00	15.0
Total bacteria, per cc	350,000	13,500
Coli-aerogenes, per cc	2,800	470
River flow, cfs	3,058	3,578

Public Works Geared to Growth

Contents in Brief—Fastest-growing city in the U.S.A. is Miami, Fla. In boom and depression periods it continues its unprecedented growth, and in one year alone the population almost doubled itself. All this is reflected in public works and services which are being expanded to meet unusual demands. Here is the story of what is happening in Miami.

THREE HUNDRED PEOPLE in 1896, 160,000 population today! This is one of the reasons why Miami is called "The Magic City," and why it lays claim to being the fastest-grow municipality in the U.S.A. And nowhere is this more evident than in the office of C. S. Nichols, director of public service, who administers a staff of more than 600 employees engaged in the expansion and operation of public works facilities to meet unusual growth demands. Even in a "magic city" public works must be carefully planned, and the construction and administration of these facilities require expert engineering. Wishful thinking never paved a street or built a sewer.

To most people Miami means a playground. To the engineer, however, it represents one of the most challenging and interesting problems in municipal development. The installation and operation of services to meet population growth requirements is only one side of the picture. Equally important in Miami is the elimination and correction of conditions which had their origin in that illogical period of growth referred to as the "boom" of 1923-26.

Results of the boom

In one year alone of that period the population jumped from 71,000 to 131,000; the city expanded in area from 9 to 42 square miles, and street mileage increased from 171 to 896! Obviously this was too much to cope with. And in the mad rush to build streets and provide other facilities much was improperly done or left undone. Subdivision promoters, for instance, were responsible for the construction of most of the streets in the "boom" days during which more than 33 sq. mi. of area was annexed to the city. These streets were

C. S. Nichols, who directs public works and services in Miami.

of such a character as to remain serviceable only long enough for the property to be sold. Now the city finds itself confronted with a task of rebuilding almost all of these pavements. Under the present program 200 mi. have been rebuilt, and 250 mi. more are slated for attention.

Funds for street work have never been adequate, and as a result there has been developed a low cost but highly serviceable pavement using a local product called pit-rock limestone. This material is an oolitic limestone that is quite soft and friable when first dug, but which hardens upon exposure to air. After it is spread on the roadway, it is rolled and scarified in place until a homogenous mass of about 5-in. thickness is produced. This is sprinkled with water which reacts with the free lime to harden and produce a dense, concrete-like base of about 1,500-lb. compressive strength. On residential streets this base is treated with about 0.25 gal. of prime oil and 0.35 gal. per sq.yd. of asphalt oil cutback over which a sand blotter is spread. The cost is about 40c. per sq.yd.

On heavy-traffic streets an 8-in. base is laid. This is also primed, and then on top of this is laid from 1 to 1½ in. of premixed wearing surface of trap rock (imported from New York) or broken crystalline limestone rock. The cost averages 55c. per square yard.

Storm drainage facilities

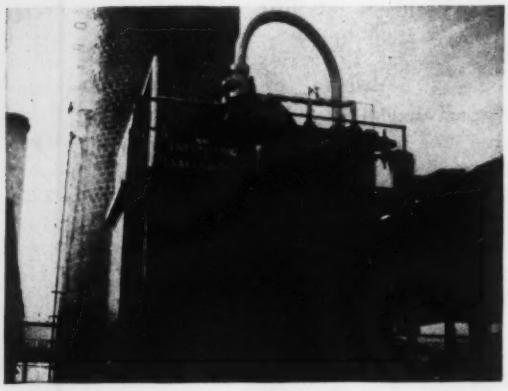
Perhaps the most pressing need in Miami is a comprehensive sewerage system and disposal plant. Sewage now pours untreated into the Miami River and Biscayne Bay from 80 outlets, and a large part of the city is unsewered. Based on the number of permits issued, septic tanks for private home disposal plants are being installed at the rate of one every 80 minutes.

Plans for the construction of a disposal plant (involving sedimentation with possible chemical treatment, sludge digestion and fertilizer production) have been prepared but no money is available. Revenue bonds for this purpose, to be paid from sewer rentals, have been considered. But to effect this method of financing, a change in the city charter must be voted. The charter now permits making charges for any and all utility services, but there is no provision for taking a lien against property should payments not be made. This must be changed in order to make the application of the sewer rental method effective.

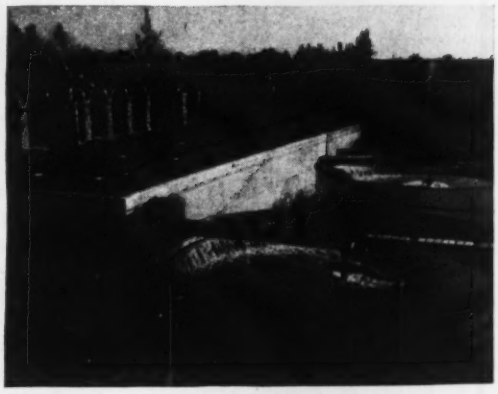
Miami has relatively little in the way of storm sewers—only about 35 mi. have been laid. In most of the residential areas ground absorption (which is very high because of the sandy soil) is depended on to remove stormwater; in the principal business section of the city storm sewers are adequate, but in some places chief reliance for drainage is placed on discharge wells. These wells are drilled beneath catchbasins at depths varying from 65 to 300 ft. The bore is usually 8 in. in diameter and the

PUBLIC WORKS IN MIAMI

The Magic City: In 1896 Miami had a population of 300, today it is a municipality of 160,000.



Power from refuse. One of the boiler installations at the city incinerator which captures waste heat.



Water softening and filtration plant with an open-air control gallery which is very attractive.

Extension of water mains is a continual job in a growing city.

Pitrock limestone, rolled and watered, forms a cement-like base for street pavements.

well is cased to a depth where it will intercept a stratum of porous rock, which quickly absorbs water.

Occasionally wells become clogged with sand (despite the fact that catch-basins are fitted with grit chambers) and the remedy is to "blow out" the bore with a compressed air jet. A discharge well, including inlets and appurtenances, costs from $1,000 to $2,000 and the city has installed about 150 of them.

Power from refuse

One of the few cities in this country to generate steam from refuse incineration, Miami has an installation which makes a handsome return on the investment. The steam operates turbine-driven pumps for the water supply and the power produced, based on a rate of $7.50 per 1,000,000 gal., saves the city about $36,000 a year; in addition, steam furnished to the city hospitals is estimated to be worth $10,000 annually.

Seven furnaces are operated at the incinerator plant but only three of these are provided with waste steam boilers for steam production. A 350-hp., a 250-hp., and a 225-hp. boiler, each connected to one furnace and operated at 125-lb. pressure, supply the demand for all the steam now needed.

The plant handles about 147,000 tons of refuse annually, of which Miami contributes about 85,000 tons. The balance comes from neighboring communities who pay the city $1.50 for each ton of material delivered at the incinerator.

Private water distribution

An unusual situation exists in regard to the water supply. The city owns and operates a 40-mgd filtration and softening plant, but the distribution of the water is handled by a private company. The latter pays the city only for that water which it has sold as shown by consumer meter readings. Thus the cost of water lost through leakage and used for fire protection purposes must be borne by the city; this amounts to about 22 per cent of the volume pumped.

Negotiations are now under way for the purchase of the distribution system which was installed by private interests in 1923. This company at one time operated its own well supply but the water became brackish and so poor in quality that practically the entire city turned to the use of bottled distilled water. It was then that the city developed new wells at Hialeah, some six miles away, and constructed a treatment plant. The supply now comes from 15 wells which produce a water with a total hardness of 288 ppm. After lime-soda softening, the finished water is supplied to the consumer with a hardness of only 90 ppm.

The job—and the men

Obviously, the administration of these varied public works and services—which in 1938 called for an operating budget of three-quarters of a million dollars and a capital outlay of some two and a half million dollars—requires efficient direction and a competent organization. The achievement of these objectives is in the hands of C. S. Nichols, a former Iowa State College professor of civil engineering who serves the city in the dual role of director of public service and city engineer. With fifteen years' administrative experience in Miami, he is the executive head responsible for the activities of the engineering department, construction of streets, bridges and sewers, inspection of buildings, plumbing and electrical work, maintenance of city property, and the operation of water supply and waste disposal facilities.

Few corporation executives can lay claim to guiding a more diversified range of activities than that encompassed by Miami's director of public service. His job calls for technical competence in several fields, a vivid but practical imagination, and an indefatigable capacity for work. But even with all these qualities, no man, single-handed, could make the wheels turn and keep them moving without a capable organization. Therefore, any mention of Miami's municipal public works operations would be incomplete without listing the names of J. R. Frink, assistant to the director; Earle M. Rader, assistant city engineer; W. L. Black, engineer of water supply; H. L. Cappleman, engineer of streets, bridges and sewers; B. B. White, superintendent of shops and wastes disposal; H. G. Maynard, superintendent of city property maintenance; and W. H. Peace, E. C. Knox and H. L. Schaller, chief inspectors of buildings, electrical and plumbing work.

Elevated Street Loop for Chicago

In view of the greatly increased traffic and congestion expected to follow the construction of several proposed superhighways radiating from Chicago, a superhighway or superstreet distributing loop has been suggested by Hugh E. Young, chief engineer of the Chicago Plan Commission. Its extent, with a length of nearly six miles, would be much greater than that of the existing elevated railway loop. Three sides of the proposed rectangular loop (along Erie, Union and Taylor streets) would be elevated, while the fourth side would be the present Outer Drive along the lake front. A novel feature proposed for the elevated portion of the work is provision for duplicate and independent structures for traffic in opposite directions. For this purpose, the plan is to take the blocks between two parallel streets and acquire a width of 55 ft. along each side of the block. Along each side then would be built an elevated street with roadway 50 ft. wide for five lanes of traffic, all in one direction, and having ramp connections to the street level. The space beneath the roadway would be available for storage or other uses, having direct frontage on the original parallel streets. A 5-ft. sidewalk would overhang the street sidewalk. For the 4½ mi. of this double elevated street (with its ten traffic lanes) the cost is estimated at $35,000,000, which includes land or right-of-way and damages to buildings.

• • •

New Board Appointed For Hartford Bridge

A commission to determine the feasibility of constructing a bridge over the Connecticut River between Hartford and East Hartford, has been named by Governor Baldwin. The new commission supersedes the old bridge board established by the 1931 legislature.

The act also provides for issuing revenue bonds in the amount of $7,000,000, to be amortized by toll levy over a period of 31 years, the toll charge not to be removed until there is enough money in the special fund to pay all bonds outstanding. The bridge is estimated to cost $6,000,000.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Scheduling Odd Jobs Saves Cableway Time

C. E. BLEE
Project Engineer
Hiwassee Dam, N. C.

A single cableway was provided for the work of building the Hiwassee Dam. The primary function of this cableway is to place concrete by means of the 7½-cu.-yd. bucket, working two 8-hr. shifts, for five days a week. To divert the cableway to any other use during these hours requires an order from the construction superintendent or the assistant construction superintendent.

There is considerable other work which must necessarily be done by the cableway, such as handling penstock steel, sluice liners, permanent gates, closure gates, etc. To make this possible, the operating crews for the cableway are scheduled so that they will be available at the noon hour and for a full shift on Saturdays. The work, other than concreting, which requires the use of the cableway, is programmed so that it may be done at these off-shift times.

• • •

Elevator Rides Dam Face

C. E. BLEE
Project Engineer, Hiwassee Dam, N. C.

The concrete in the spillway of Hiwassee Dam will ultimately rise about 230 ft. above the elevation of the parallel service bridge floor, so that two materials elevators, one for light loads and one for heavy duty, have been developed to operate to the top of the concrete at whatever elevation it may be. In building each of the elevators the length of the legs was adjusted to the slope of the downstream face of the dam so that the load platform is kept horizontal. The light-duty elevator has a sheet-metal tray, 56x30 in. in size, for carrying the load, and operates on four 5-in. rubber-tired swivel casters. The lifting power is supplied through a single ½-in. steel cable to a pneumatic hoist of ½-ton capacity, located on the panel form at the top of the block. The heavy-duty elevator (illustrated) provides a load platform 6x10 ft. in size, and operates on four standard Ford truck wheels with 30x5-in. pneumatic tires. Power from the ½-ton hoist on the bridge deck is applied to the elevator through a two-part ½-in. cable. A gooseneck crane has been built on the panel form by welding sections of 6-in. pipe, and is used to facilitate unloading the elevator.

Service elevator on face of Hiwassee dam.

The service bridge, together with the elevators, affords a means of delivering form ties, reinforcing steel, pipe, bolts and the many other items of construction materials to the top of the concrete blocks in an area where there is no other convenient means of access, except the 18-ton cableway. The cableway is reserved for concrete placement during the working shifts, as noted previously.

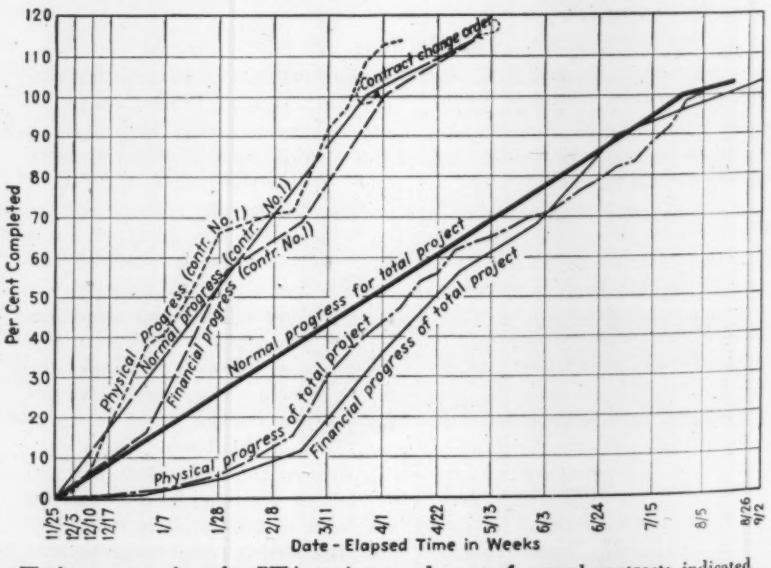
• • •

Progress Chart for PWA

H. P. HOPKINS
Resident Engineer,
Consoer, Townsend & Quinlan,
Chicago, Ill.

The method shown by the chart of keeping an accumulative record of construction progress on PWA projects involving several contracts is recommended as being very simple and quite adaptable to this type of work. The chart shows for each contract and for the project as a whole (1) the normal line or straight line progress, which would be maintained if the job were theoretically on schedule at all time, (2) the actual weekly accumulative physical progress and (3) the financial progress or payments made to the contractor.

From the chart one can see at a glance the status of the project and



Work progress chart for PWA projects; only one of several contracts indicated.

$3 to $5
paid on acceptance for items suitable for the pages of From Field and Office

of the individual contracts, both physically and financially. The difference between the physical progress and financial progress lines serves as a quick check on the account of money paid to the contractor each month, in comparison to the actual construction progress. Weekly physical estimates are made from the items shown on the contractors' breakdown or detailed estimate sheet (PWA Form No. 96).

This method has also proved helpful in estimating the date of completion of each contract and of the whole project, particularly in cases where it becomes necessary to ask for an extension of contract time.

The writer uses a sheet of 24x36-in. coordinate paper and colored lines to record progress on a project covering nine contracts. This chart, tacked up so that the contractors may see it, also proves helpful in making them realize when they are behind and how much added speed is necessary to catch up to schedule.

• • •

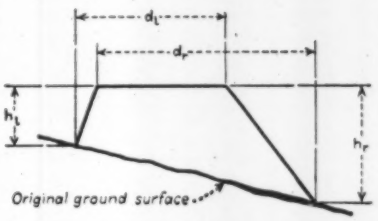
Measuring Embankment Volume

ROBERT J. FLETCHER
Rochester, N. Y.

When on the job some time ago I had occasion to note that measurements on a long earth dike were being taken in a difficult way. As available references gave no better method I developed the following:

To determine the volume of a fill of the general section shown without recourse to original cross-section notes or construction stakes, the method here given requires the least labor in the field (with accompanying decrease in opportunity for error), and a minimum of computations in the office.

At each cross-section where it is desired to obtain the area, the top of fill being sensibly level and it being reasonable to assume uniform the slope of the original ground surface underneath the fill, it is necessary to take only the four measurements shown on the diagram: The vertical height from the top of fill to the toe of slope on the right, the vertical height from the top of fill to the toe of slope on the left, the horizontal distance from the left toe of slope to the right edge of the top of fill, and the horizontal distance



from the right toe of slope to the left edge of the top of fill. The area of the section equals $\frac{1}{2}$ $(h_l\ d_r + h_r\ d_l)$.

It is unnecessary, and complicates the office computations that follow, to measure separately the width of the top of fill, to bisect this, and then to proceed with the field of measurements as with a three-level section; the center height in any case is unknown. In general, to obtain the width of the top and to bisect it requires two men on the top of slope; only one man at a time is required on top by the method recommended.

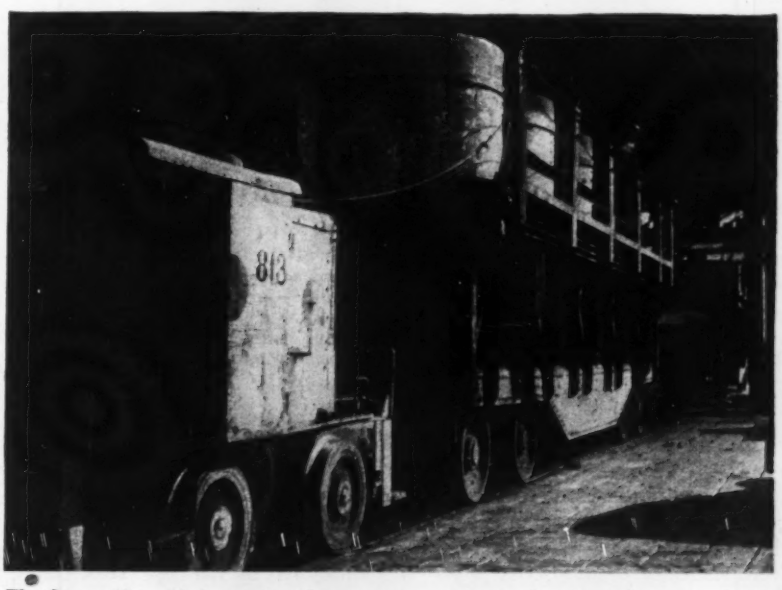
• • •

One Man Spots Buckets By Remote Control

Four-cubic-yard concrete buckets, moving from the mixing plant out on the trestle at Grand Coulee Dam, now are spotted by one man in place of the crew of two used in earlier stages of this job. Two men formerly were used because the operator in the cab of the 12-ton diesel-electric locomotive was not able to see from that position exactly where the train should be stopped and depended upon signals from a second man standing beside the bucket to be spotted. In the new arrangement the one operator stands beside any one of five stations and instead of signaling to the locomotive cab he operates the cab controls himself with the aid of a remote control mechanism using compressed air.

One of these remote control stations is located opposite each of the concrete buckets. At each station there are three levers controlling, respectively, throttle, reverse and brake. This improvement in operation procedure, devised by the staff of Consolidated Builders, Inc., has been highly satisfactory in speeding up operation and reducing risk of error.

At each of the control stations are three levers: throttle, reverse, and brake.



The locomotive cab is empty; the operator stands on the elevated runway beside the 4-cu.yd. bucket at any one of five remote control stations.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Pipe Corrosion

SOIL CORROSION AND PIPE LINE PROTECTION—By Scott Ewing. 277 pp. Published by the American Gas Association, 420 Lexington Ave., New York. Price $2.50.

PIPE CORROSION AND COATINGS—By Erick Larson. 455 pp. Published by American Gas Journal, Inc., New York. Price $2.50.

Soil corrosion and pipe protection information is voluminous but widely scattered. Therefore, the two books now available in which much of the existing data has been brought together and coordinated are particularly valuable. Both books cover essentially the same ground in the presentation of corrosion theories and various methods of protection. Of special interest in the Ewin book is the chapter on cathodic protection and electrolysis. The Larson book lays particular emphasis on the manufacture and application of pipe coatings.

The Earth as a Structure

ARCHITECTURE OF THE EARTH—By Reginald Aldworth Daly. 211 pp. Published by D. Appleton-Century Co., New York. Price $3.

This book describes, in clear and concise style, the construction of the earth and of the natural features of the earth's surface, the materials and forces involved in this construction, and the manner in which the forces are applied. Thus, although not written especially for engineers and not definitely applicable to their practical problems, its subject matter has a unique relation to that of the engineering profession. The book should, therefore, be of interest and value to engineers in enlarging their cultural and professional horizon.

Throughout the volume it is evident that the architecture or engineering involved in the construction of the earth transcends the ordinary fields of architecture and engineering in the vastly greater pressures and higher temperatures that are involved, radically changing the physical properties of the structural materials. The most important clues as to these properties have been afforded in recent years by the geophysical methods.

The four principal hypotheses of the original condition and early development of the earth are first outlined. The first of the succeeding chapters briefly describes the structure of the earth's crust where it emerges from the ocean to form continents and islands. The second chapter deals with the inaccessible, and much the greater, part of the crust; the third, with the deformations suffered by the crust during the ages. The fourth and fifth chapters describe spectacular invasions of the crust by molten rock, risen from the deep interior of the globe. The sixth chapter considers the reasons why, through geological time, the high-standing continents, the higher-standing mountains and volcanic piles, and the low-standing ocean floors are supported at their respective levels. Every engineer who has worried about the foundations of the puny structures he has planned will appreciate the magnitude of the problem of the foundations of the great mountain ranges.

The book contains 152 illustrations, which greatly illuminate the text. Most of them may, with some license, be considered as "blue prints" of the earth structures that are described.—*Reviewed by* O. E. MEINZER, *U. S. Geological Survey, Washington, D. C.*

Refuse Incineration

INCINERATION, Carbonization and Reduction of Garbage, Rubbish and Sewage Sludge—A Bibliography prepared at New York University by U. S. Works Progress Administration. 146 pp. Limited free distribution through the sanitary engineering department of the university, New York City.

A bibliography and brief abstracts of more than 500 references to articles, books and patents dealing with refuse and sewage sludge incineration, has been prepared by WPA workers engaged on a research project sponsored by the New York City Department of Sanitation. The bibliography has a threefold objective, namely (1) to cover the history and description of the various methods of incineration; (2) to select data on carbonization, reduction, fills and hog feeding, sufficient for an unbiased comparison and evaluation of these processes as compared to incineration; (3) to compile the entries and index the material in such a way as to facilitate further research.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

ROAD MATERIAL STUDIES carried out by the Instituto Sperimentale Stradale, Milan, Italy, are reported in "Ricerche e Studi," Vol. II. Though the pamphlet is published in Italian, each study is followed by a brief summary in several languages, including English, which will be helpful to those who do not read Italian.

ECONOMIC CONDITIONS affecting the building of homes are the subject of "Residential Building," Housing Monograph Series No. 1, National Resources Committee. The study was prepared by Lowell J. Chawner of the Bureau of Foreign and Domestic Commerce. Copies are obtainable from the Superintendent of Documents, Washington, D. C. Price, 10c.

SUGGESTIONS for use in making an industrial and commercial survey of a city or of a metropolitan region for the purpose of improving the city's position as a marketing area are given in a bulletin of the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, known as Domestic Commerce Series No. 105. The pamphlet is obtainable from the Superintendent of Documents, Washington, D. C., price, 10 c. The text is supplemented by an 18-page itemized and classified outline of the main features of such a survey and a list of the general sources of the information desired for the survey.

MANAGING LOW-RENT HOUSING, a record of current experience and practice in public housing, is a record of addresses and discussions at the meeting of the Management Training Institute, held at Washington, D. C., in June, 1938. This institute was or-

(*Continued on p.* 78)

…pe and often corrugating the …ustrated above produce a filing action …economy to operate wire rope over scored or …heaves. Select the proper sheave material, depending on …rope pressure encountered.

SAFE RADIAL PRESSURES FOR VARIOUS MATERIALS
(Lb. per Square Inch for Projected Area of Rope)

MATERIAL	6x17	6x19	6x37	8x19	REMARKS
Wood	150	250	300	350	
Cast iron	285	475	570	665	Average Brinnell hardness, 125
Carbon steel castings	540	900	1080	1260	0.30-0.40% Carbon Average Brinnell hardness, 160
Chilled cast iron	660	1100	1320	1540	Must be uniform hardness
Manganese steel	1500	2500	3000	3500	Grooves should be ground

Unit radial pressure... $P = \frac{2T}{Dd}$ Where T = Tension in pounds
D = Tread diameter of sheave or drum, inches
d = Diameter of rope, inches

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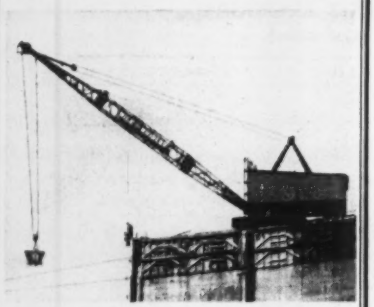

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(Continuel from page 76)

ganized and conducted by the National Association of Housing Officials in collaboration with the U. S. Housing Authority and local authorities operating large scale projects. The volume, price $2, is No. N-100 of the National Association of Housing Officials, 1313 East 60th St., Chicago, Ill.

PROCEEDINGS of the American Railway Bridge and Building Association for 1938 may be obtained from the secretary, C. A. Lichty, 319 North Waller Ave., Chicago. Price, $2.00.

NEW ENGINEERING BOOKS

STEAM AND HOT WATER FITTING—By William T. Walters. 184 pp. Published by American Technical Society, Chicago. Price $2.

BAUGRUND UND BAUWERK—By Franz Kogler and Alfred Scheidig. 288 pp. Published by Wilhelm Ernst & Sohn, Berlin. Price 17.65 RM, cloth bound.

MANNING FORMULA TABLES, Vol. 2—By Horace Williams King. 379 pp. Published by McGraw-Hill Book Co., New York and London. Price $5.

This book supplements a similar book on pipe flow problems published in 1937 under the same title but not designated as Volume 1.

GRANTS-IN-AID UNDER THE PUBLIC WORKS ADMINISTRATION—By J. Kerwin Williams. 292 pp. Published by Columbia University Press, 2960 Broadway, New York City. Price $3.75.

RECLAMATION 1902-1938—A SUPPLEMENTAL BIBLIOGRAPHY—Compiled by John J. Gaul. Regional Checklist No. 6. 98 pp. Published by the Denver Public Library and the State Dept. of Education, Denver, Colo. Price $1.

STEEL SQUARE—By Gilbert Townsend. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago. 96 pp. Price $1.25.

REPORTS AND PAMPHLETS

ADHESION OF ASPHALT TO AGGREGATES IN THE PRESENCE OF WATER—By Prevost Hubbard. Circular 19. Reprinted by the National Sand and Gravel Association, Munsey Bldg., Washington, D. C.

FUNDAMENTALS OF RIVER AND CANAL HYDRAULICS—Published by Rama Krishna & Sons, Lahore, India. Price Rs. 2.

LEGAL PROBLEMS IN THE HOUSING FIELD—Prepared for the Industrial Committee of the National Resources Committee. For sale by the Superintendent of Documents, Washington, D. C. Price 25c.

GOVERNMENTAL PLANNING MACHINERY—Publication No. 63. Obtainable from the Public Administration Service, Chicago, Ill. Price $1.

NEW BEDFORD, Mass.—Annual Report of the Commissioner of Public Works to the City Council, 1938.

NEW JERSEY—Bulletin No. 46, Work of the New Jersey Geodetic Control Survey, 60 Outwater Lane, Garfield, N. J.

ABACO PARA O CALCULO DOS ESCANAMENTOS PELA FORMULA DE WILLIAMS AND HAZEN—May be obtained from Ministerio da Viaca e Obras Publicas, Rio de Janeiro.

ELECTRIC POWER STATISTICS 1938—Federal Power Commission, Washington, D. C. Price 25c.

ASPHALT—ORIGIN, HISTORY, DEVELOPMENT—Its Relation to Petroleum—By Joseph Rock Draney. Reprint from *Americana*. May be obtained from Asphalt Institute, New York City.

BASIC PRINCIPLES OF HEALTHFUL HOUSING—Second Edition. May be obtained from American Public Health Association, 50 West 50th St., New York City. Price 25c.

MARYLAND—Some Planning Accomplishments of the 1939 General Assembly of Maryland. May be obtained from the Maryland State Planning Commission, Baltimore.

PAPERS PRESENTED AT THE TWENTY-SIXTH ANNUAL CONFERENCE ON HIGHWAY ENGINEERING—Bulletin No. 86. University of Illinois, Urbana, Ill. Price 50c.

PAPERS PRESENTED AT THE SECOND CONFERENCE ON AIR CONDITIONING—Bulletin No. 76. University of Illinois, Urbana, Ill. Price 50c.

THE FLOOD PROBLEM IN FIRE PREVENTION AND PROTECTION—May be obtained from the National Board of Fire Underwriters, 85 John St., New York City.

NOTES ON PORTLAND CEMENT—Vol. II—By Thaddeus Merriman. A *Delaware Water Supply News* reprint, 346 Broadway, New York City.

INDIA—A Short Account of the Recent Development of Road Communications in the Province of Assam, India. May be obtained from the Assam Government Press, Shillong, India. Price 1s. 9d.

PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL ROAD SCHOOL—Extension Series No. 44, Engineering Extension Dept., Purdue University, Lafayette, Ind.

THE PLACE OF THE ENGINEER IN CIVILIZATION—Series of addresses by D. B. Steinman. May be obtained from N. C. State College of Agriculture and Engineering, Raleigh, N. C.

CHARTS FOR THE DESIGN OF TIMBER BEAMS—Prepared by V. D. Limaye. May be obtained from Forest Research Institute, Dehra Dun, U. P., India.

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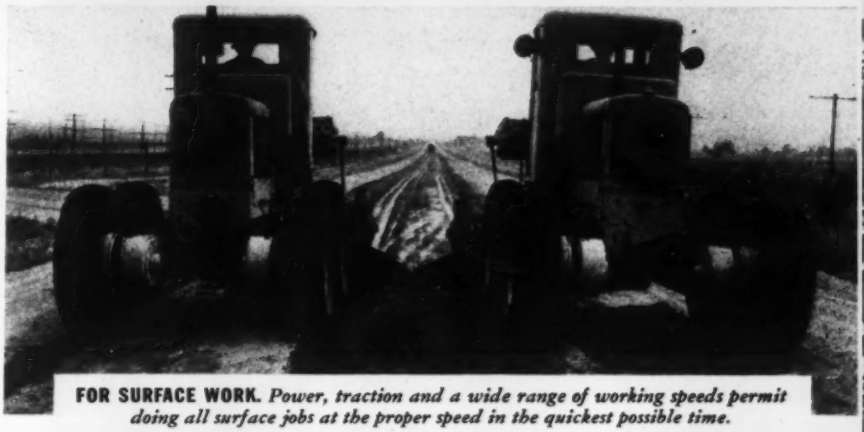
OR BANK WORK. *It takes less than a inute to put the blade on Adams otor graders out into this high bank- utting position.*

● Cutting high banks . . . cutting deep ditches . . . processing heavy oil and stabilization mix . . . light, high-speed maintenance . . . heavy scarifying and grading . . . cutting fine grades . . . finishing shoulders . . . building roads complete from ditch to ditch . . . all of these jobs and many more are every-day work for Adams Heavy-Duty Motor Graders. They are the most versatile and most valuable machines any contractor or road official can own . . . Powered by 62½ h. p. Diesel or 66½ h.p. gasoline engines, they have the power to "go through" on any job. A wide range of working speeds permits doing the job in quickest possible time. A high transport speed of 18 m.p.h. saves time and money in going from job to job.



FOR SURFACE WORK. *Power, traction and a wide range of working speeds permit doing all surface jobs at the proper speed in the quickest possible time.*

If you do not need a big machine, see Adams No. 302 with 45½ h.p. engine, or the No. 20 with 22½ h.p. engine. Ask your local representative to show you any or all of these machines; if you do not know his name, address

J. D. ADAMS COMPANY • Indianapolis, Indiana

Branches, Representatives & Distributors throughout United States

FOR DITCH WORK. *Many officials and contractors are using Adams motor graders altogether for building and reshaping ditches.*

ADAMS

Motor Graders

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WATERFRONT HIGHWAY PITTSBURGH, PA.

OWNER: Allegheny County Department of Public Works, Pittsburgh, Pa.; John F. Laboon, director.

PROJECT: Constructing portion (Contract 5) of new express two-level highway along Water Street on Monongahela side of Pittsburgh's "Golden Triangle". Includes 8-ft. sidewalk and two 30-ft. roadways separated by ramps to 40-ft. wide lower level. Inner roadway occupies present location of Water St., and outer is elevated over wharf space and part of lower level. Reinforced cantilever type retaining wall between inner road and underpass aids in protection against flood.

CONDITIONS: Work to be completed by June 30, 1940. Contractor to furnish all materials. Rail, highway and water transportation available. Wage rates on project are: skilled, $1.75 per hr.; semi-skilled, $1.00 per hr.; and common, 80c per hr.

BIDS: Five bids were opened Julv 27, 1939, ranging from the contract low of $533,775 to $552,555.

LOW BIDDERS:

1. John F. Casey Co., Aspinwall, Pa. (contract) $533,775
2. Navarro Corporation, Pittsburgh, Pa..... 537,617
3. George Vang, Inc., Pittsburgh, Pa..... 539,922

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Class 1 excav	6,000 c. y.	$2.00	$1.50	$2.00
2. Class 2 excav	19,000 c. y.	5.75	5.00	6.50
3. Std. Cl. A conc. incl. excav., refilling and anchor bolts	13 c. y.	35.00	35.00	35.00
4. Extra depth conc., light pole fndn	1 c. y.	10.00	75.00	50.00
5. Cl. A conc., traffic isl., incl. dowels	28 c. y.	20.00	35.00	20.00
6. Embank and refill, gran. slag	1,000 c. y.	1.50	1.50	1.80
7. Granul. slag backfill	400 c. y.	1.85	1.50	1.80
8. Cl. A conc. for abutments, ret. wall, backwall, br. seat	2,500 c. y.	27.00	20.00	21.00
9. Cl. A conc., subdeck slabs, curbs, fascias, coping	570 c. y.	30.00	40.00	26.00
10. Pavmt. conc., top rdway	547 c. y.	20.00	25.00	15.00
11. Cl. A conc., traffic isl., walks (reinf.)	68 c. y.	22.50	35.00	20.00
12. Cl. B concrete	2,600 c. y.	20.00	20.00	17.00
13. Conc. sidewalk on grade	9,000 s. f.	.35	.40	.40
14. Concrete sidewalk	550 s. f.	.55	.75	1.00
15. Rein. conc. pavement (1 crse.)	8,500 s. y.	3.60	3.80	2.50
16. Conc. pavmt., mesh reinf	100 s. y.	3.00	3.25	3.00
17. Conc. std. curb	800 l. f.	1.65	2.00	1.75
18. Conc. std. curb, with underdrain	750 l. f.	3.50	2.50	3.00
19. Conc. spec. curb, 12-in	700 l. f.	2.25	2.15	2.00
20. Conc. spec. curb, 16-in	880 l. f.	2.50	2.40	2.00
21. Conc. spec. curb, railing fndn., underdrain of perf. clay pipe	120 l. f.	6.00	3.00	3.00
22. Conc. spec. curb, railing fndn	130 l. f.	7.25	3.50	4.00
23. Cl. A conc. guard on curb	120 l. f.	1.50	2.50	3.00
24. Cl. A conc., endwalls	3 c. y.	20.00	40.00	21.00
25. Cl. A conc., spec. endwalls	25 c. y.	35.00	40.00	21.00
26. Spec. conc. gutters	350 l. f.	1.25	1.00	1.50
27. Conc. cradle, pipe culv	30 c. y.	15.00	25.00	21.00
28. Cement	8,000 sacks	.25	.20	1.15
29. Gravel, base course	800 s. y.	.75	.80	1.00
30. Membrane waterprfg	1,750 s. y.	1.25	1.50	2.50
31. Tar waterproofing	2,700 s. y.	.50	.50	.60
32. 10-in. C.I. pipe, culv	48 l. f.	4.00	5.00	8.00
33. 16-in. C.I. pipe, culv	84 l. f.	5.25	8.00	11.00
34. 6-in. clay pipe, culv	40 l. f.	1.40	2.50	4.00
35. 8-in. clay pipe, culv	60 l. f.	1.60	2.75	5.00
36. 15-in. clay pipe, culv	620 l. f.	3.00	3.60	6.00
37. 15-in. clay pipe, sewer	520 l. f.	13.00	4.50	6.00
38. 9-in. clay pipe, house lateral	160 l. f.	3.00	2.50	7.00
39. 36-in. brick sewer, complete	300 l. f.	53.00	75.00	65.00
40. Brick catch basins, type 1 & 2	7 ea.	320.00	140.00	130.00
41. Reconstr. type 1 catch basin	1 ea.	200.00	100.00	130.00
42. Brick catch basin, type 6	3 ea.	230.00	200.00	130.00
43. Brick storm inlets, type 1	2 ea.	230.00	150.00	115.00
44. Brick storm inlet, type 5	1 ea.	200.00	130.00	115.00
45. Brick storm inlet, type 6	4 ea.	200.00	150.00	115.00
46. Brick manholes	6 ea.	400.00	175.00	150.00
47 Spec. brick m. h., 36-in. sewer	1 ea.	200.00	250.00	300.00
48. Extra depth catch basin, type 1 or 2	15 l. f.	10.00	15.00	22.00
49. Extra depth brick manholes	15 ea.	10.00	15.00	22.00
50. Malleable iron gratings	1 ea.	30.00	100.00	35.00
51. Stone backing	450 c. y.	6.00	8.00	7.00
52. Std. conc. vaults, incl. drains	22 ea.	85.00	100.00	115.00
53. Spec. conc. vaults, incl. drains	5 ea.	140.00	600.00	650.00
54. 6-in. underdr., perf. clay pipe	120 l. f.	1.00	1.25	1.50
55. Med. carbon copper brg. steel	1,120,000 lb.	.054	.07	.06
56. Chrome nickel iron	3,300 lb.	.75	1.50	.75
57. Malleable iron castings	3,000 lb.	.40	.25	.40
58. Steel castings	28,000 lb.	.15	.20	.16
59. Copper waterseals	3,200 lb.	.50	.60	.75
60. Reinforcing bars	700,000 lb.	.05	.05	.05
61. 6-in. wr. iron pipe	100 l. f.	3.25	4.00	3.50
62. Concrete piles	17,000 l. f.	2.60	2.60	2.80
63. Steel sheet piling	9,500 s. f.	.30	.70	.75
64. Steel sheet piling, left in place	4,000 s. f.	.70	.60	.65
65. ¾-in. asphalt plank	1,700 s. y.	1.50	2.00	3.00
66. Rein. conc. sidewalk over vault	160 s. f.	1.50	1.25	1.00
67. 30-in. c. i. pipe, cement lined	236 l. f.	32.00	25.00	23.00
68. 6-in. centr. c. i. pipe, cem. lined	24 l. f.	7.00	5.00	7.00
69. 30-in hub gate valve	1 ea.	1,000.00	1,500.00	500.00
70. 6-in. hub gate valve	1 ea.	50.00	60.00	50.00
71. 6-in. single nozzle hydrant	1 ea.	100.00	100.00	110.00
72. C. I. deep frames and covers	18 ea.	30.00	25.00	40.00
73. Brick masonry, waterlines	35 c. y.	45.00	40.00	40.00
76. Conc. masonry, waterlines	15 c. y.	15.00	25.00	30.00
77. Misc. steel and iron	2,000 lb.	.20	.10	.10
78. Additional excav	30 c. y.	3.00	3.00	6.00

BRIDGE AND GRADE SEPARATION, MICHIGAN

OWNER: Michigan State Highway Commission, Lansing; M. D. Van Wagoner, commissioner.

PROJECT: Constructing 15 span reinforced concrete and steel bridge and grade crossing elimination structures over Saginaw River and Michigan Central Railroad tracks on Court St., Saginaw, Mich. Bridge portion of structure consists of one 40-ft. rolled beam span, one 120-ft. clear deck girder span providing for future bascule opening, three 85-ft. deck girder spans and three 40-ft. rolled beam spans supported by two bascule type piers. Both structures provide for 6-ft. sidewalks and 42-ft. roadway.

CONDITIONS: Local traffic access to Court St. buildings must be maintained. Railroad traffic schedules are also to be kept. Contractor to furnish all materials and work must be completed by June 1, 1940. Rail, highway and water transportation available. Minimum wage rates for the project are: skilled, $1.12½ per hr.; semi-skilled, 75c. per hr.; and common, 50c. per hr.

BIDS: Seven bids were received June 21, 1939, ranging from the contract low of $407,769 to $460,048.

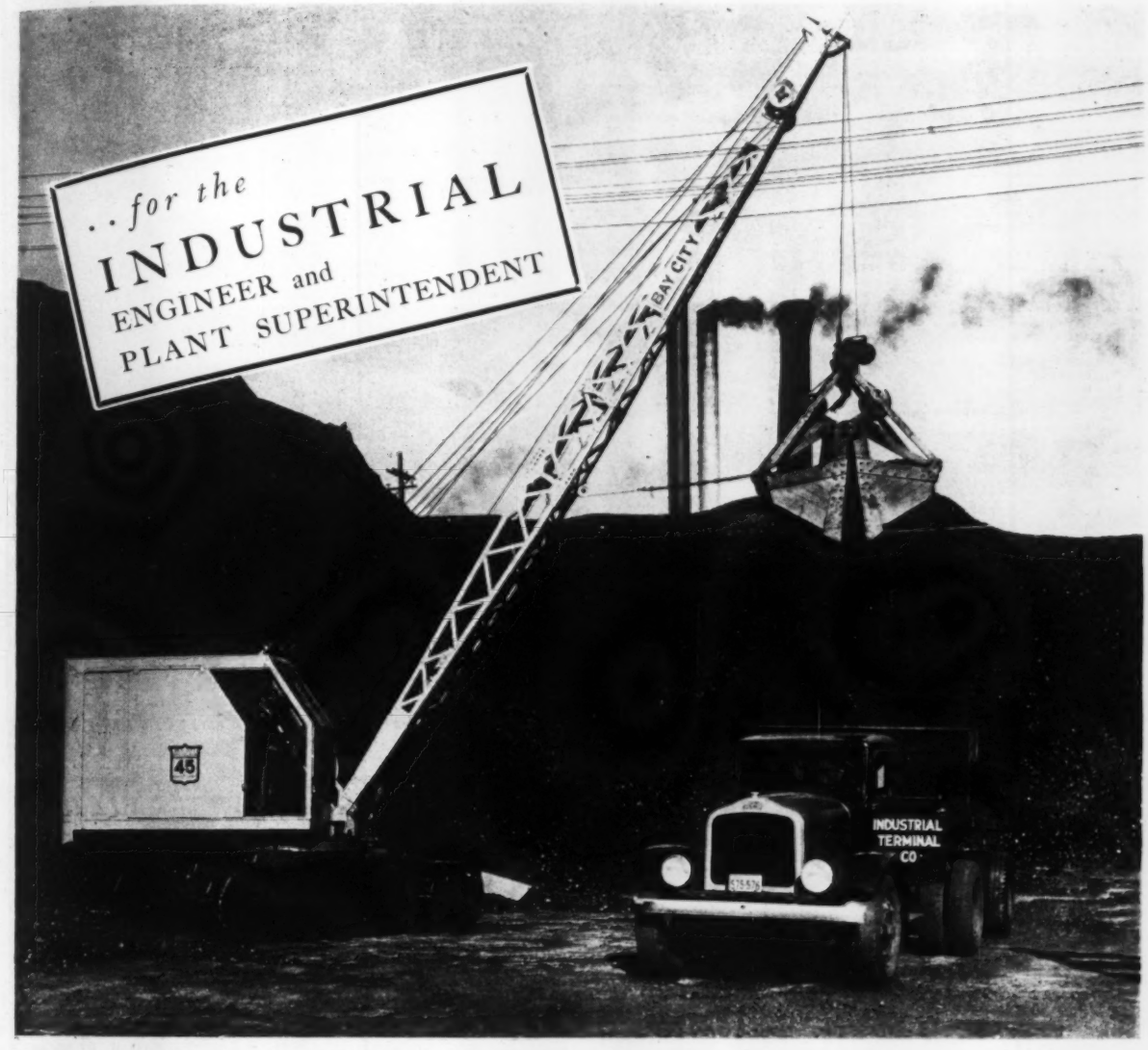
LOW BIDDERS:

1. Wm. J. Meagher, Bay City, Mich. (contract) $407,769
2. L. A. Davidson, Lansing, Mich..... 419,729
3. Owen-Ames-Kimball Co., Grand Rapids, Mich. 421,157

GRADE SEPARATION

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dry excavation	1,887 c. y.	$1.50	$1.00	$2.00
2. Wet excavation	180 c. y.	3.00	4.00	4.00
3. Timber sheet piling, left in place 3-in. butt jt	344 s. f.	.50	.50	.50
4. Steel sheet piling, left	5,392 s. f.	1.00	.70	1.50
5. Tr. timber piles, furn	80 l. f.	.75	1.20	.60
6. Tr. timber piles, driven	72 l. f.	1.00	1.00	.80
7. Conc., grade A, substr	999 c. y.	16.00	16.00	18.00
8. Conc., grade A, superstr	422 c. y.	13.00	10.00	20.00
9. Heat and house mass conc	235 c. y.	1.50	1.50	1.50
10. Heat and house neat conc	227 c. y.	3.50	3.50	3.50
11. Cement	2,134 bbl.	2.25	2.00	2.25
12. Reinforcing steel	171,634 lb.	.04	.035	.055
13. Structural steel	434,000 lb.	.0493	.045	.055
14. Railing	770 l. f.	5.00	4.00	5.00
15. Field painting	L.S.	500.00	500.00	1,000.00
16. Rubbed surface finish	12,354 s. f.	.10	.10	.10
17. Special surface finish	389 s. f.	.25	.50	.15
18. ½-in. joint filler, cork	45 s. f.	.50	1.00	.50
19. Copper	606 lb.	.30	.50	.80
20. Sidewalk frame and cover	6 ea.	17.75	10.00	10.00
21. 6-in. std. wr. iron pipe	81 l. f.	3.00	2.00	5.00
22. 6-in. std. c.i. pipe	311 l. f.	3.20	2.00	5.00
23. Safety coil vault	2 ea.	25.00	10.00	20.00
24. Service connection	L.S.	220.00	145.00	160.00
25. Br. rdwy. lighting circuit	L.S.	975.00	568.00	600.00
26. Under bridge lighting	L.S.	313.00	175.00	200.00
27. Lighting unit, end type	2 ea.	115.00	102.00	125.00
28. Lighting unit, intermed. type	4 ea.	117.00	106.00	125.00

(*Contract unit prices continued on page* 82)



"handles 2000 tons of coal on 50 gallons of gas"

*Based on 52 lbs. to foot, averaging 50 cu. ft. or 2,600 lbs. coal plus 3,750 lbs. for bucket.

The Industrial Terminal Company, Detroit, Mich., installed this standard BAY CITY ¾-yard crane, equipped with 40-foot boom and 1½ yard rehandling bucket for loading coal. The cataloged crane capacity at 35′ is 4600 lbs., yet in checking the load, this machine is handling a total of *6,350 lbs. representing an overage of 1,750 lbs. at this radius.

These figures talk your language if you are looking for high performance at low cost. Owner reports averaging 140 tons per hour and that machine "handles 2,000 tons of coal on 50 gallons of gas". Compare this with your records—then let us show you how a BAY CITY can reduce your costs. Before making up your budget write for our 32 page descriptive Catalog H-1-A. No obligation.

BAY CITY SHOVELS, INC., BAY CITY, MICHIGAN

Export Office: H. M. Hein, 330 W. 42nd St., New York, N. Y. (Oparo)

BAY CITY SHOVELS

(Contract unit prices continued from page 80)

RIVER BRIDGE

Item	Quan	Unit Prices (1)	(2)	(3)
1. Remove existing struct	L.S.	$18,746.27	$18,000.00	$19,000.00
2. Dry excavation	454 c. y.	1.50	2.00	2.00
3. Wet excavation	3,863 c. y.	3.00	10.00	4.00
4. Furn. timber piles	45,874 l. f.	.35	.35	.20
5. Drive timber piles	43,832 l. f.	.40	.20	.30
6. Furn. tr. timber piles	5,982 l. f.	.70	.80	.60
7. Drive tr. timber piles	5,641 l. f.	.30	.50	.30
8. Tr. protection piles, furn	5,760 l. f.	.80	.80	.65
9. Tr. protection piles, driven	5,568 l. f.	.35	.50	.40
10. Tremie concrete	1,289 c. y.	15.00	20.00	13.00
11. Grade B conc., substr	4,578 c. y.	15.00	18.00	12.00
12. Grade A conc., substr	1,093 c. y.	15.00	12.00	18.00
13. Grade A conc., superstr	797 c. y.	13.00	10.00	20.00
14. Heat and house mass conc	2,683 c. y.	1.50	1.50	1.50
15. Heat and house neat conc	708 c. y.	3.50	3.50	3.50
16. Cement	11,056 bbl.	2.25	2.00	2.25
17. Reinforcing steel	292,188 lb.	.04	.035	.055
18. Struct. steel	1,396,000 lb.	.0549	.05	.062
19. Cast steel bearings	1,330 lb.	.30	.30	.30
20. Bronze plates	302 lb.	.40	.50	.50
21. Railing	1,110 l. f.	5.00	4.00	5.00
22 Field painting	L.S.	1,000.00	1,400.00	2,820.00
23. Rubbed surface finish	29,284 s. f.	.10	.10	.10
24. ½-in. joint filler, cork	70 s. f.	.50	1.00	.50
25. 1-in. joint filler, cork	38 s. f.	.80	1.00	1.00
26. Copper	1,005 lb.	.30	.50	.80
27. Sidewalk frame and cover	12 ea.	17.75	10.00	10.00
28. 3-in. galv. iron downspout	126 l. f.	1.50	.50	.60
29. Cast iron nosing	876 lb.	.30	.10	.10
30. Casting, c.i. type 1 outlet	16 ea.	10.00	5.00	6.00
31. Casting, c.i. type 2 outlet	12 ea.	10.00	5.00	10.00
32. Furn. tr. timber and lumber	23.8 Mbm.	72.00	80.00	80.00
33. Place tr. timber and lumber	23.8 Mbm.	30.00	30.00	60.00
34. Miscellaneous hardware	9,500 lb.	.18	.10	.10
35. Safety coil vault	2 ea.	25.00	10.00	20.00
36. Br rdway lighting circuit	L.S.	1145.00	864.00	950.00
37 Navigation lighting	L.S.	480.00	476.00	525.00
38. Lighting unit, end type	2 ea.	115.00	102.00	125.00
39. Lighting unit, intermed. type	8 ea.	117.00	106.00	125.00
40. Channel excavation	3,100 c. y.	1.50	1.00	1.00

DISTRIBUTION SYSTEM NEBRASKA

OWNER: Central Nebraska Public Power and Irrigation District, Hastings, Nebr., Charles B. Fricke, chief engineer and general manager.

PROJECT: Construction of water distribution system from main lateral E-65, including earthwork and structure, Main lateral E-65-19.1 and Small Lateral Distribution System from Main laterals, E-65-19.1 and E-65-23.7, Kingsley Dam.

CONDITIONS: Bids were asked on corrugated metal pipe or precast concrete pipe system. Contract awarded on basis of corrugated metal pipe construction. Rail and highway transportation available. Contractor to furnish all materials. Wage rates: skilled $1.00 to $1.12 per hr.; semi-skilled 53 to 82½c. per hr.; and common, 50c. per hr.

BIDS: Six bids were received July 20, 1939, ranging from contract low of $351,995 to $428,868. Engineer's estimate $360,000.

LOW BIDDERS:

1. John Kerns Constr. Co., Omaha, Nebr. (contract) $351,995
2. Roberts Constr. Co., Lincoln, Nebr..... 362,677
3. Bushman Constr. Co., St. Joseph, Mo..... 369,827

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Common, excav. laterals	1,029,710 c. y.	$0.084	$0.10	$0.092
2. Compacted embank	112,894 c. y.	.15	.17	.20
3. Common excav. struct	52,580 c. y.	.40	.55	.50
4. Miscellaneous iron	14,067 lb.	.16	.12	.15
5. Class A concrete	1,658 c. y.	18.60	19.50	21.00
6. Reinforcing steel	175,475 lb.	.049	.042	.06
7. Tr. timber, struct	626 M.b.m.	144.90	136.00	130.00
8. Untr. bridge timber	101 M.b.m.	65.00	65.00	80.00
9. Untr. timber piling	890 l. f.	.87	.85	.70
10. Corr. metal pipe, 12-in	1,222 l. f.	.92	.71	1.00
11. Corr. metal pipe, 18-in	160 l. f.	1.50	1.20	1.25
12. Corr. metal pipe, 24-in	44 l. f.	1.96	1.57	1.90
13. Corr. metal pipe, 30-in	238 l. f.	2.42	1.94	2.20
14. Corr. metal pipe, 36-in	32 l. f.	3.62	3.09	3.50
15. Corr. metal pipe, 42-in	86 l. f.	4.34	3.64	4.00
16. Corr. metal pipe, 48-in	86 l. f.	5.07	4.19	4.75
17. 12-in. corr. met. pipe, dipped	84 l. f.	1.20	1.00	1.50
18. 21-in. corr. met. pipe, dipped	16 l. f.	2.19	1.88	2.20
19. 48-in. corr. met. pipe, dipped	18 l. f.	6.38	5.37	5.00
20. 18-in. corr. met. pipe	4,418 l. f.	1.50	1.20	1.25
21. 21-in. corr. met. pipe	1,520 l. f.	1.77	1.39	1.50
22. 24-in. corr. met. pipe	3,208 l. f.	1.96	1.57	1.90
23. 30-in. corr. met. pipe	4,353 l. f.	2.42	1.94	2.20
24. 36-in. corr. met. pipe	1,092 l. f.	3.62	3.08	3.50
25. 42-in. corr. met. pipe	818 l. f.	4.34	3.64	4.00
26. 48-in. corr. met. pipe	494 l. f.	5.07	4.19	4.75
27. 54-in. corr. met. pipe	118 l. f.	6.94	5.88	6.00
28. 18-in. corr. met. pipe, dipped	536 l. f.	1.86	1.62	2.00
29. 21-in. corr. met. pipe, dipped	396 l. f.	2.19	1.88	2.20
30. 24-in. corr. met. pipe, dipped	2,459 l. f.	2.49	2.13	2.50
31. 30-in. corr. met. pipe, dipped	746 l. f.	2.98	2.64	3.00
32. 36-in. corr. met. pipe, dipped	313 l. f.	4.56	3.96	4.00
33. 42-in. corr. met. pipe, dipped	48 l. f.	5.52	4.66	5.00
34. 48-in. corr. met. pipe, dipped	40 l. f.	6.38	5.37	6.50
35. 66-in. corr. met. pipe, dipped	65 l. f.	10.65	8.97	9.00
36. 18-in cast iron pipe	75 l. f.	7.59	7.09	8.00
37. 24-in. cast iron pipe	300 l. f.	11.06	10.45	12.00
38. 30 in. cast iron pipe	96 l. f.	12.18	13.95	15.00
39. Cl. A gravel surf	250 c. y.	1.67	1.25	2.00
40. Sand, gravel backfill, RR	257 c. y.	1.62	1.50	2.00
41. 12-in. meter gate assembly	75 ea.	31.00	33.37	40.00
42. 18-in. meter gate assembly	8 ea.	40.00	42.60	45.00
43. 24-in. meter gate assembly	3 ea.	58.00	53.04	60.00
44. 30-in. meter gate assembly	16 ea.	90.00	86.85	100.00
45. 36-in. meter gate assembly	2 ea.	114.00	103.50	110.00
46. 42-in. meter gate assembly	2 ea.	152.00	146.72	150.00
47. 48-in. meter gate assembly	2 ea.	178.00	161.28	170.00
48. 12-in. gates, min. wt. 60 lb.	5 ea.	16.00	17.30	20.00
49. 21-in. gates, min. wt. 171 lb.	1 ea.	34.00	31.02	40.00
50. Lock and chain assembly	2,052 ea.	1.64	1.95	2.00
51. Number plates, tim. struct.	1,532 ea.	1.30	.10	.50
52. Stencil numbers, conc. struc	378 ea.	.92	.10	.40
53. Class E riprap	2,494 c. y.	5.57	6.10	7.00
54. 4x4 sluice gate, hoist	1 ea.	388.00	393.00	400.00
55. Steel, pipe flumes	5,125 lb.	.16	.11	.10
56. 30-in. weld. steel pipe	328 l. f.	6.72	5.88	7.00
57. Cable guard rail	400 l. f.	.78	1.00	1.00
58. Anchors, cable guard rail	16 ea.	4.00	1.00	10.00
59. Remove cable guard rail	400 l. f.	.09	.10	.20
60. Reset cable guard rail	400 l. f.	.26	.15	.20
61. Clearing	1 ac.	36.00	100.00	25.00
62. Grubbing	1 ac.	69.00	150.00	25.00

HIGHWAYS, NEW MEXICO

OWNER: New Mexico State Highway Department, Santa Fe, N. Mex., E. L. Stockton, Albuquerque, district engineer.

PROJECT: Construction of State Aid Projects 146 and 147 in San Juan and McKinley Counties on U. S. Route 666 between Gallup and Shiprock. Approximate length 82.6 miles. Consists of minor relocations, drainage structures, base course surfacing and single penetration top.

CONDITIONS: Contract must be completed in 350 weather working days. Wage rates on the job are: skilled, $1.00 to $1.25 per hr.; semi-skilled, 45c. to $1.00 per hr.; and unskilled, 40c. per hr.

BIDS: Ten bids were opened on July 28, 1939, ranging from the contract low of $405,301 to $488,864. Engineer's estimate $391,021.

LOW BIDDERS:

1. W. T. Bookout, Las Vegas, N. Mex. (contract) $405,301
2. A. O. Peabody, Santa Fe, N. Mex..... 407,925
3. L. R. Allison, Albuquerque, N. Mex..... 437,976

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove drainage struct	L.S.	$800.00	$500.00	$3,000.00
2. Remove obstructions	L.S.	200.00	100.00	5,000.00
3. Unclass. excavation	172,638 c. y.	.11	.10	.40
4. Excav., pipe culverts	889 c. y.	1.00	1.50	2.00
5. Overhaul	350,524 sta. y.	.02	.01	.02
6. Haul	69,825 ½ mi. y.	.04	.04	.08
7. Two course surfacing	354,797 ton	.50	.56	.46
8. Cl. B conc., headwalls	2 c. y.	50.00	30.00	30.00
9 Reinforcing steel	68 lb.	.20	.10	.12
10. 24-in. rein. conc. pipe	4,228 l. f.	3.00	2.70	3.00
11. 30-in. rein. conc. pipe	1,004 l. f.	4.25	4.00	4.25
12. 36-in. rein. conc. pipe	1,352 l. f.	6.50	5.50	5.75
13. 48-in. rein. conc. pipe	32 l. f.	15.00	10.00	9.00
14. Obliterate old road	1.903 mi.	100.00	100.00	50.00
15. Grouted riprap	190 c. y.	10.00	10.00	20.00
16. Rock and wire check dams	38 c. y.	9.00	6.00	12.00
17. Compacting embankment	94 hr.	5.00	3.00	10.00
18. Watering	11,191 M gal.	3.50	1.00	.50
19. Rolling	4.943 hr.	2.50	1.00	.50
20. Asph. road oil, (MC-1)	9,326 bbl.	4.10	4.00	6.00
21. Cover material	22,546 ton	2.00	3.00	1.70
22. Asphalt	9,203 bbl.	3.60	4.00	5.50

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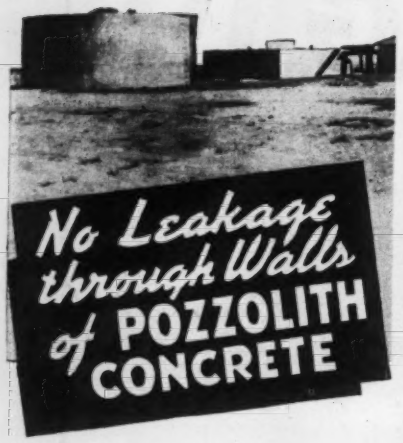
WICKWIRE ROPE

Every wire of a new rope is completely encased with a film of oil. The oil storage is the impregnated hemp center. The supply is sufficient to last for the life of the rope provided "washing out" and evaporation are prevented by the occasional slushing of the outside surface with grease. Should a wire rope become rust-bound through neglect, it is necessary to free the bearings of wire against wire by the use of a thin penetrating oil. A well lubricated rope operates with minimum internal friction. Hence, wire fatigue and internal wear are reduced with the natural resultant of longer wire rope life.

WICKWIRE SPENCER STEEL COMPANY

General Offices: 500 Fifth Avenue, New York City; Sales Offices and Warehouses: Worcester, New York, Chicago, Buffalo, San Francisco, Los Angeles, Tulsa, Chattanooga, Houston, Abilene, Texas, Seattle. Export Sales Department: New York City

POZZOLITH



"We were much pleased with the workability and denseness of the concrete obtained," reports Mr. H. R. F. Helland, Construction Engineer on the Sewage Treatment Plant at Pecos, Texas. "When the structures were filled with water for test, there was no leakage through the walls. This was gratifying as a similiar concrete structure built a few years ago with the same type aggregates had many leaks."

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(Continued from page 37)

MEN AND JOBS

ADOLPH J. ACKERMAN, development engineer for the engineering works and contracting division of the Dravo Corp., Pittsburgh, Pa., has been appointed director of engineering. A graduate of the University of Wisconsin with degrees in electrical and civil engineering, Ackerman has been active in the design and construction of various types of dams and hydraulic structures. He holds patents on automatic spillway gate operating mechanisms as used on the Bonneville dam. Ackerman was formerly with the Stone & Webster on Conowingo dam and with the Aluminum Co. of America on the Calderwood and Chute á Caron projects. Other new appointments with the Dravo Corp. are L. YLVISAKER as works manager for the engineering works division; A. J. DAWSON, chief engineer for the engineering works division; and G. H. ATWOOD, chief draftsman for the engineering works division.

CAPT. ROLAND C. BROWN has begun his new duties, being in charge of land acquisition and relocation phases of the $50,000,000 Denison Dam project on Red River of Texas. Other army officers in charge of the building of Denison Dam include: CAPT. LUCIUS D. CLAY, district engineer; CAPT. JAMES H. STRATTON, military assistant in charge of flowage; LIEUT. JOHN HICKS ANDERSON, chief assistant to Capt. Stratton.

WALTER BYRNE, vice-president of Thomas Kilpatrick & Co., is replacing T. A. LEISEN as general manager of the Metropolitan Utilities District of Omaha. Col. Leisen will continue until Jan. 1, as secretary to the Board. He has been its manager since 1923.

ALBION N. VAN VLECK, first deputy commissioner of housing and buildings, New York City, this week is returning to resume his practice as consulting engineer, to be associated with William Raisch & Associates, consulting engineers, New York City. The William Raisch firm specializes in foundations, buildings and structures, industrial plants, sewage disposal plants, and water supply improvements.

HENRY SLATTERY, Greenville, S. C., has been appointed administrator of the Rural Electrification Administration, succeeding JOHN M. CARMODY, who became head of the Federal Works Agency three months ago. Slattery has served in the Department of Interior in various capacities for a number of years and since May of last year has been chief aid to Secretary of Interior Ickes.

GEORGE SMITH, road construction engineer, has been appointed by the Ontario Department of Highways to take over the construction of all roads for Nairn Centre, Ontario.

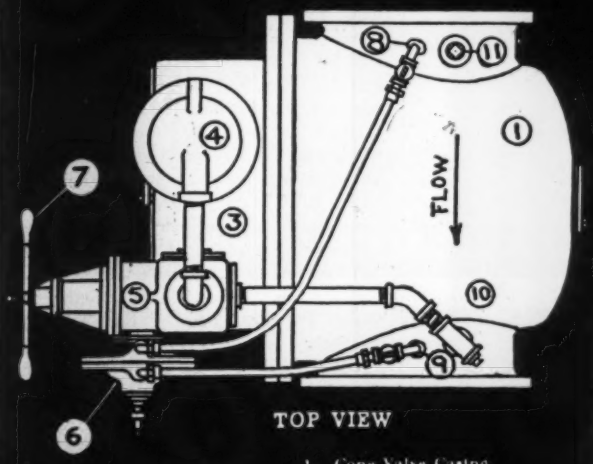
CHARLES B. PARSONS, Waco, Tex., engineer of the U. S. Veterans Administration, has been transferred to Fayetteville, N. C., to supervise the construction of a new $1,500,000 veterans hospital. Sol B. Fischel, another veterans administration engineer, has also been assigned to this work.

JOHN N. EDY, city manager of Toledo, O., has been appointed administrative assistant to John M. Carmody, Federal Works Administrator. Edy will assume his new duties Oct. 2 to act as budget director of FWA, coordinating the budget requests of the five constituent agencies. He has been city manager of Toledo since 1936 and for a year previous to that he was assistant director of the U. S. Budget Bureau. He has also been city manager at Berkeley, Calif., Flint, Mich., and Dallas, Tex. Previous to that he was chief engineer of the Montana state highway department.

HENRY NOLLAN, for many years executive manager of the Mountain-Pacific chapter of the Associated General Contractors of America, at Seattle, Wash., has accepted the position of personnel director for the three firms building the $12,700,000 navy air bases at Kodiak island and Sitka in Alaska, the three firms being the Siems-Spokane Co., of Spokane; Johnson, Drake & Piper Co., Minneapolis, and the Puget Sound Bridge & Dredging Co., Seattle. Nollan was senior inspector for the Seattle city engineering department until 1927, at that time becoming executive manager of the Western Public Works Contractors Association, which later consolidated with the Mountain-Pacific chapter. John H. Thomas will serve as acting manager for the chapter to replace Nollan.

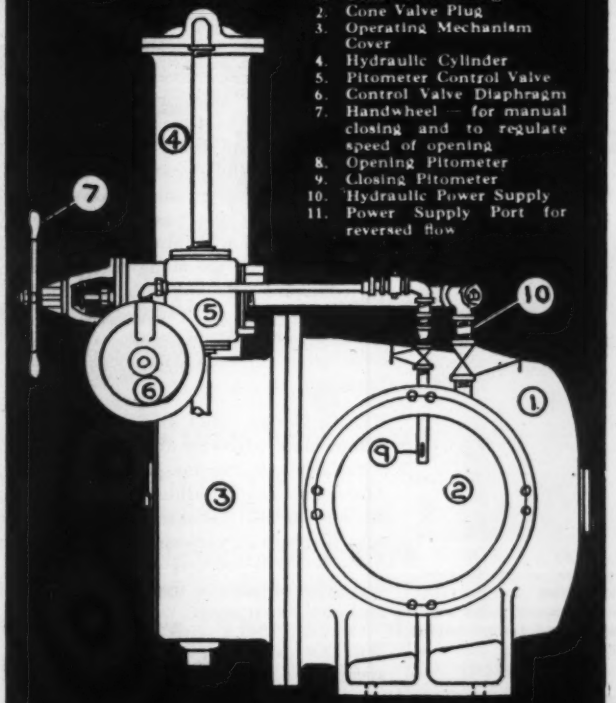
REAR ADMIRAL S. M. ROBINSON, inspector of naval material at the General Electric Co., Schenectady, N. Y., has been named chief of the Navy Bureau of Engineering. According to Acting Secretary of the Navy Edison, Admiral Robinson in the near future will be given additional orders in coordinating shipbuilding which will place him directly over both the Bureau

STOP and CHECK with Chapman AUTOMATIC CONE VALVES



TOP VIEW

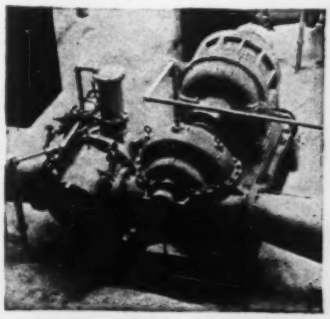
1. Cone Valve Casing
2. Cone Valve Plug
3. Operating Mechanism Cover
4. Hydraulic Cylinder
5. Pitometer Control Valve
6. Control Valve Diaphragm
7. Handwheel — for manual closing and to regulate speed of opening
8. Opening Pitometer
9. Closing Pitometer
10. Hydraulic Power Supply
11. Power Supply Port for reversed flow



SIDE VIEW

The introduction of centrifugal pumps for pumping station service developed need for a satisfactory check valve which the Chapman Automatic Cone Valve was designed primarily to supply. Wide use from coast to coast as a stop-check valve in pumping station service is proof of its superior qualifications and fine service rendered.

Chapman Automatic Cone Valves are made in all sizes from 6″ to 48″, with various control and operating mechanisms to meet the needs of various uses and operating conditions. For *stop-check* use in pumping station or similar service, we know of no other type valve so effective or reliable.

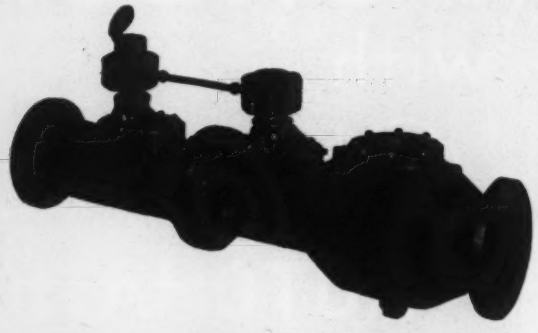


Typical Installation Chapman Automatic Stop-Check Cone Valve on a pump discharge. Equipped for Hydraulic Operation and Pitometer Control.

THE CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASS.

SPARLING MAIN-LINE COMPOUND METERS



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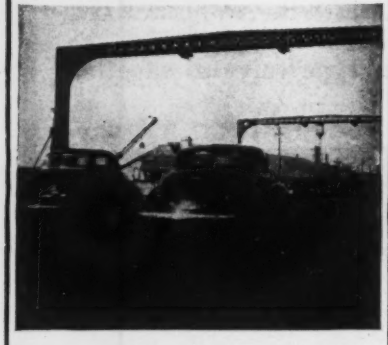

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IRRIGATION DITCH IN TEXAS

Above is shown a section of a finished "GUNITE"-lined irrigation ditch in the Rio Grande delta, Texas, part of many miles built by this method. Ditches of this design, being free from joints, exclude vegetation and are leak-proof.

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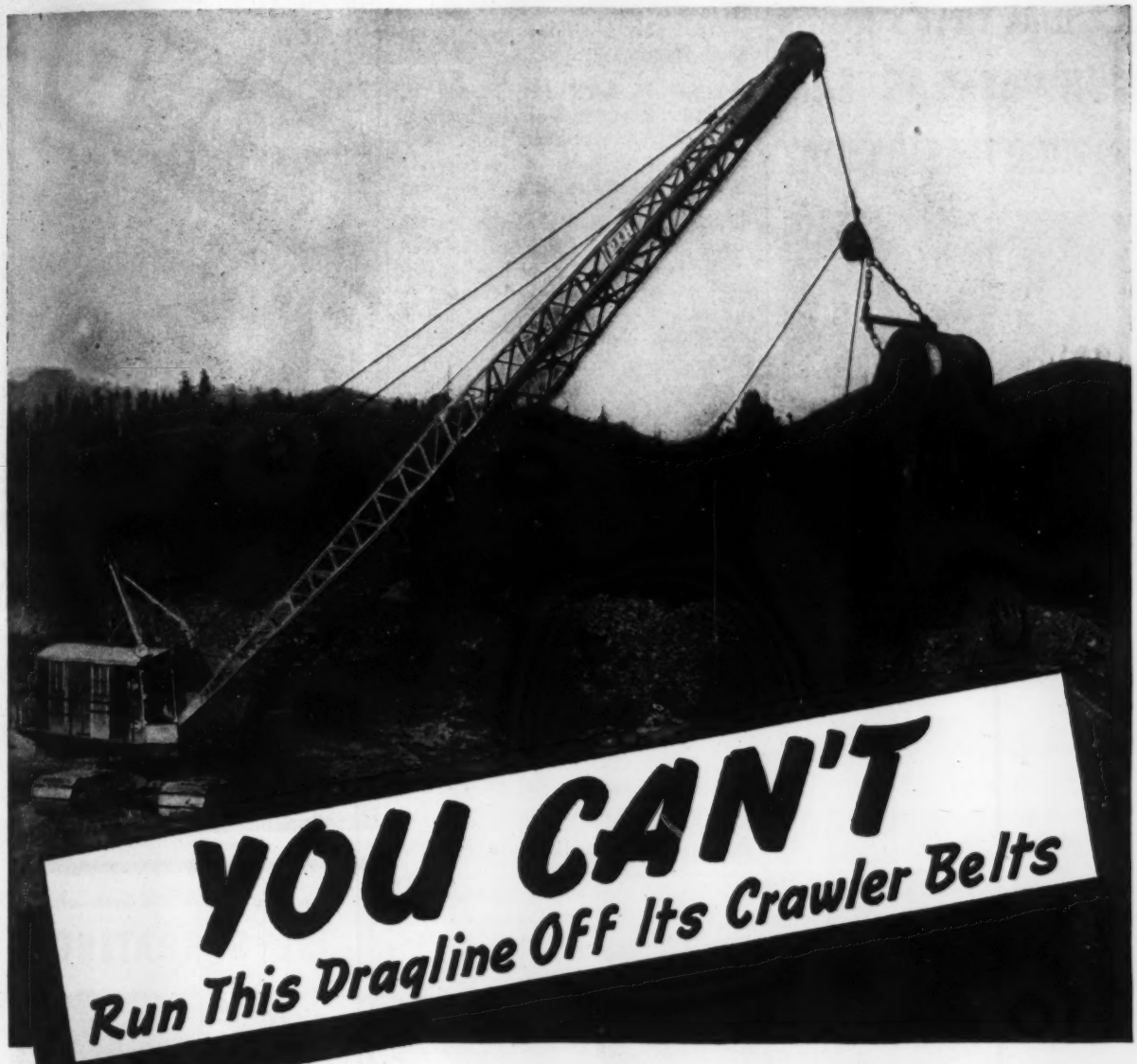
of Engineering and the Bureau of Construction and Repairs. He has been a senior member of the Compensation Board in the Navy Department since April 1938 and succeeds Rear Admiral HAROLD G. BOWEN, who recently completed four years of duty as chief of the Engineering Bureau. Other changes in the navy force include Rear Admiral WILLIAM G. DUBOSE, chief of Bureau of Construction and Repairs, who has been made director of the David W. Taylor Model Basin, and he will be succeeded by Captain ALEXANDER H. VAN KEUREN, industrial manager of the Philadelphia Navy Yard; Captain LEWIS B. MCBRIDE, director of the David W. Taylor Model Basin, will begin new duties at the Washington Navy Yard in connection with construction and the experimental ship model basin at that place; Captain CHARLES W. FISHER, JR., has been named director of the Shore Establishments Division in the office of the Assistant Secretary of the Navy; Admiral A. T. CHURCH has been made director of the Naval Engineering Experimental Station, Annapolis, Md., a post temporarily filled by Commander JOHN O. HUSE.

DUGALD C. JACKSON, JR., has been appointed dean of the college of engineering at the University of Notre Dame. Jackson was president of the Lewis Institute in Chicago from 1935 until the fall of 1938, prior to that being head of the department of electrical engineering at the University of Kansas. During the past few months, in collaboration with his father, he has been working on the study of engineering education, conducted by the Engineer's Council for Professional Development and financed by the Carnegie Foundation for the Advancement of Teaching.

HAL G. SOURS, chief engineer and assistant state highway director in Ohio, is the sole nominee for president of the American Road Builders Association. He has served the association for the past 12 years in various capacities and if elected will succeed Murray D. Van Wagoner, director of the Michigan state highway department.

WILLIAM JOHNSON, of Kenton, O., has accepted a position as assistant engineering draftsman at Wright Field, Dayton, Ohio, for U. S. War Department.

COL. CHARLES L. HALL, district engineer of the army engineers in New York, has been promoted to acting division engineer of the North Atlantic Division to succeed Col. Francis B. Wilby, recently named Chief of Staff of the First Army with headquarters at Governors Island. Colonel Hall was graduated from West Point in 1908 and dur-



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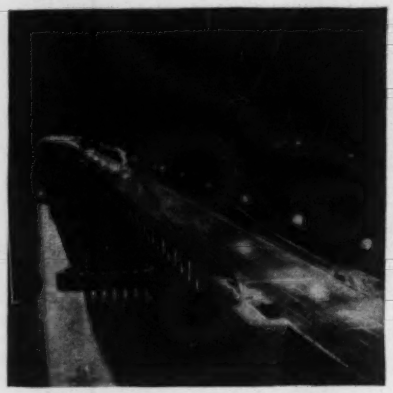

G-E sodium-lighted San Francisco—Oakland Bay bridge, leading to Treasure Island

SUPPOSE the 25,000,000 passenger cars in the United States were driven through an eight-mile stretch of two-way traffic at the rate of 25,000 cars a day.

Wouldn't it be amazing if *only one accident occurred for every million car-miles traveled?*

Yet that's identical with the enviable record set to date on the 8¼-mile stretch of the California State Highway Commission's San Francisco–Oakland Bay Bridge, which was opened to traffic on November 12, 1936.

G-E Sodium Lighting Contributes to Safety

And the built-in G-E sodium safety lighting has contributed much toward making this one of the world's safest stretches of highway.

Sodium is helping to hold the night-to-day accident ratio down to 1.26 to 1. It is helping toward the realization of the bridge engineer's dream—a bridge that is as safe at night as it is by day.

Sodium Lighting Saves Lives

Installations all over the country on bridges, highways, dangerous corners, and in tunnels are proving that sodium lighting does bring a substantial decrease in night accidents—saves lives. For further information, write General Electric Company, Schenectady, New York.

GENERAL ELECTRIC

500-92B

ing the administration of President Taft was one of the military aides at the White House.

ASHER W. HARMAN, of Richmond, Va., has begun new duties as city manager of Bristol, Va., succeeding P. A. Goodwyn. Harman is a civil engineering graduate of Virginia Military Institute.

C. S. LYNCH, chief engineer for the Arkansas Power & Light Co., has been elected to the board of directors of that company to fill the vacancy caused by the recent death of H. Grady Manning. Lynch, who joined the company in 1920, is a graduate of the College of Engineering at the University of Missouri. Load dispatcher, construction engineer and engineer in charge of the construction of Carpenter Dam, a hydroelectric project on the Ouachita River, are three positions he has held with the company.

WILLIAM KANTOLA has been named city engineer of Conneaut, O., succeeding Paul Holmstrom. Kantola was chief engineer when the city's new waterworks was built and also designed plans for Conneaut's stadium.

ROBERT L. HARDMAN, PWA resident engineer on the Yampa Irrigation District dam in Colorado, has now joined the Army Engineers in the Panama Canal Zone on construction.

D. C. SUTHERLAND, engineer with the Colorado state highway department, has resigned to accept a position with the Western Portland Cement Association, becoming representative in Wyoming.

ROMEO MOVISSETTE, consulting engineer of Drummondville, Que., has been named town engineer at Victoriaville, Que.

H. S. BLISS and M. C. BLISS, both of Brainard, Minn., and W. B. ROY, Sioux Falls, S. D., have organized and incorporated the Bliss Engineering Co. at Sioux Falls.

MEETINGS

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual fall meeting, Pennsylvania Hotel, New York City, Oct. 2–5.

PAN AMERICAN HOUSING CONFERENCE, Buenos Aires, Oct. 2–7.

AMERICAN GAS ASSOCIATION, 21st Annual Convention, Hotel Pennsylvania, New York City, Oct. 9–12.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Richmond, Va., Oct. 9-13.

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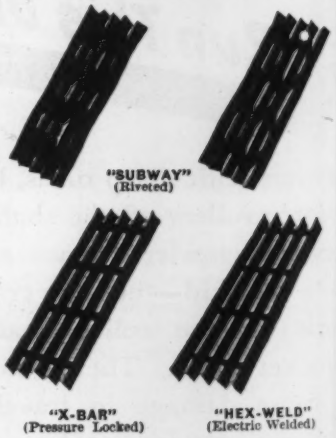

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